

**INVESTING IN AMERICA'S BROADBAND
INFRASTRUCTURE: EXPLORING WAYS TO
REDUCE BARRIERS TO DEPLOYMENT**

HEARING

BEFORE THE

**COMMITTEE ON COMMERCE,
SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE**

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

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INVESTING IN AMERICA'S BROADBAND INFRASTRUCTURE: EXPLORING WAYS TO REDUCE BARRIERS TO DEPLOYMENT

WEDNESDAY, MAY 3, 2017

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 10 a.m. in room SR-253, Russell Senate Office Building, Hon. John Thune, Chairman of the Committee, presiding.

Present: Senators Thune [presiding], Nelson, Wicker, Cantwell, Blunt, Klobuchar, Sullivan, Blumenthal, Fischer, Schatz, Moran, Markey, Cruz, Booker, Heller, Peters, Gardner, Hassan, Capito, Cortez Masto, Lee, and Inhofe.

OPENING STATEMENT OF HON. JOHN THUNE, U.S. SENATOR FROM SOUTH DAKOTA

The CHAIRMAN. Well, good morning. This morning our Committee meets again to explore ways to promote broadband investment and deployment. Before opening our discussion on infrastructure, I want to take a moment to welcome and thank our friends to the North for joining us here today. Our colleagues from the Canadian House of Commons serving on the Standing Committee on Industry, Science, and Technology, have joined us today to talk about how our two nations can learn from one another regarding improving broadband connectivity. The members of this committee extend a warm welcome to you, and we look forward to our continued dialogue on broadband policy.

Improving our Nation's infrastructure is a bipartisan goal that Congress and the administration share. In March, we heard from a diverse panel of witnesses who spoke of the issues facing our Nation's infrastructure across several sectors of our economy. One of our witnesses, Shirley Bloomfield, speaking on behalf of NTCA—the Rural Broadband Association, offered insight about the benefits that stem from deploying and modernizing broadband infrastructure. As we all know, access to broadband is critical to everyday life and is a driving force behind much of the economic growth we've experienced over the last two decades.

Particularly in areas like South Dakota, keeping up with the demand for access to broadband can be challenging. Rural communities unfortunately often lag behind their urban counterparts due to more challenging geographies and lower population density. To address this disparity, a major part of our continuing discussion on

improving the Nation's infrastructure should include solutions to reducing any unnecessary hurdles to broadband deployment.

As we look to potential solutions, we must be mindful of the tremendous investment made to deploy these services and look for opportunities to help cut through red tape. For example, many wireless carriers are already deploying next-generation small cells that are the size of a pizza box and thus reducing the need for larger towers and minimizing environmental impact.

To help foster more deployment, we must ensure the regulatory regime in place is reflective of these advances in technology. Speeding up deployment will also come from eliminating unnecessary red tape and delays. As my colleagues from Alaska, Minnesota, Wisconsin, and other northern states already know, in places like South Dakota, you are lucky if you have a 6-month window to undertake the hard work of deploying broadband infrastructure, whether that's laying fiber, erecting towers, or building satellite Earth stations. This makes any bureaucratic delay in securing permits even more damaging in states like ours.

In South Dakota, for instance, Golden West Telecommunications has to start the permitting process 1 to 2 years before it can begin putting fiber in the ground, and sometimes even that is not enough.

In April 2015, Golden West began the process of securing permits to deploy fiber facilities in Custer, a mile-high city in the Black Hills with a population of about 2,000 people. Due to delays particularly from the National Forest Service, Golden West didn't get the necessary approvals until this past November, some 18 months later. Well, on Monday, it was still snowing in the Black Hills. Nevertheless, after more than 2 years of waiting, Golden West is ready to start digging just as soon as the weather clears. In the meantime, a multimillion dollar project has been on hold, good jobs have been deferred, and valuable Internet service has been delayed.

Today, I hope that we will explore ways to facilitate faster broadband deployment and avoid these unnecessary delays. We must be cognizant, however, of the role our local communities have in authorizing and managing the deployment of physical infrastructure. Many businesses serving these communities, like Midco in South Dakota, have developed great partnerships within their footprint, and we, as policymakers, want to encourage such relationships to thrive.

A good starting point for addressing many of these issues is for the Senate to immediately take up and pass the MOBILE NOW Act, which this committee approved during our first markup in January. This bipartisan bill would streamline the process of applying for easements, rights-of-way, and leases for federally managed property, and would establish a shot clock for review of those applications.

MOBILE NOW would also establish a national broadband facilities asset database listing government property that could be used by private entities for the purpose of building or collocating communications facilities. For all these reasons, it's my hope in the coming weeks we'll finally see Senate passage of the MOBILE NOW Act.

As Congress considers developing legislation to improve the Nation's infrastructure, our discussion here today will help build a constructive record regarding America's digital infrastructure.

I look forward to hearing from our distinguished panel today, and I want to thank you all for your willingness to testify.

I want to turn now to Senator Nelson for any opening remarks he may have.

Senator Nelson.

**STATEMENT OF HON. BILL NELSON,
U.S. SENATOR FROM FLORIDA**

Senator NELSON. Thank you, Mr. Chairman.

This is an important topic. We have neglected our infrastructure for so long. And, of course, when we talk about infrastructure, it's not just roads and bridges, it's not just airports and seaports, it's the expansion of broadband. And I'm particularly pleased that Mayor Gary Resnick, of Wilton Manors, Florida, is here with us for the second time, to provide a local perspective that is so important to this issue of expansion of high-tech broadband. It's clear that we're right here on the cusp of another leap forward in wireless communications.

And also at the table this morning, a company, SpaceX. Companies like this are preparing to launch innumerable satellites that basically will cover communications for the entire planet—communications directly off of a satellite. So we're going to have innumerable opportunities, terrestrial wireless companies are focused on deploying the next-generation 5G wireless service, and that will provide many consumer benefits and likely serve as the backbone for our increasingly connected economy. And then the more we're connected, then the only thing we have to worry about, Mr. Chairman, is keeping the Russians out of all of our communications.

So in looking at an infrastructure package, this Committee has already talked about the necessity of direct spending for broadband expansion. So we're going to look today at whether there are other non-monetary measures Congress could or should take to improve our nation's digital infrastructure.

So, many of us at the Federal level to the State level to the local level around the country want Americans to benefit from the availability of robust wireless. Building these networks has always brought up a number of very sensitive issues: historic preservation, environmental concerns, state and local land use policies, tribal sovereignty, national security. And the advent of 5G brings with it networks that require installation of much denser wireless infrastructure made up of many more small facilities. So I hope that all of our stakeholders, including those represented here today, can work together to find ways to effectively balance all of these competing concerns.

Now, with that said, I want to say something else about a different subject. The question many have asked me, following last week's announcement by the FCC Chairman Pai, that he intends to roll back the Commission's net neutrality rules, "Where," they ask me, "do we go from here as lawmakers?"

Well, I certainly believe American consumers deserve better than what the FCC Chairman is proposing. They need to know, the con-

sumers, that we have their back, and they deserve certainty and finality when it comes to their essential right to a truly free and open Internet protected by clear, enforceable net neutrality rules.

That lasting finality can only come from legislation, which the Chairman and I have been talking about for a couple of years, which is why this Senator has been open to finding a bipartisan solution on this issue. That solution cannot merely pay lip service to net neutrality, but it must include real protections for consumers and empower the FCC with flexible, forward-looking authority over broadband providers. Otherwise, we're going to be in this "never never land" where the FCC will say something and then it will be tied up in the courts for years, and it will go from one court to another.

If we could ever get a bipartisan legislative solution, then that solves the problem, but, of course, that's not easy. Net neutrality legislation is not going to happen overnight, even when you have the kind of goodwill that the Chairman and I do, and the members of this committee do. The reality is that right now we're facing that there are too many folks, from Chairman Pai to the stakeholders and lawmakers, that are dug in on a particular side of this issue, so it's making compromise an impossible task.

So this Senator is an optimist by nature, but it's pretty clear to me that the climate just isn't ripe at the moment for a legislative solution that would lead to real substantive legislation that could garner sufficient bipartisan support, but that doesn't mean we shouldn't be trying. And this Senator will continue to try.

Thank you, Mr. Chairman.

[The prepared statement of Senator Nelson follows:]

PREPARED STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM FLORIDA

Mr. Chairman, today we have another opportunity to talk about the importance of infrastructure to our economy, and in particular, the promise that comes with the next generation of wireless broadband. I am pleased that Gary Resnick, mayor of the great City of Wilton Manors, Florida, will once again join us today to provide an important local government perspective.

It is clear that we are on the brink of a yet another leap forward in wireless communications. Companies like SpaceX are preparing to launch innovative global networks made up of hundreds of satellites in order to provide true high-speed, satellite-based broadband service. Terrestrial wireless companies are focused on deploying next-generation 5G wireless service, which will provide many consumer benefits and likely serve as the backbone for our increasingly-connected economy.

In looking at an infrastructure package, this committee has already talked about the necessity of direct spending for broadband expansion. Today, we look at whether there are other, non-monetary measures Congress could—or should—take to improve our Nation's digital infrastructure.

Everyone—from those of us in the Senate to our mayors and local officials around the country—want Americans to benefit from the availability of robust wireless broadband. Building these networks has always brought up a number of very sensitive issues—from historic preservation and environmental concerns to state and local land use policies, tribal sovereignty, and national security. And the advent of 5G brings with it networks that require installation of much denser wireless infrastructure, made up of many more smaller facilities.

I continue to hope that all stakeholders, including those represented before us today, can work together to help us find ways to effectively balance the competing concerns about siting and construction of wireless facilities and consumers' increasing demand for fast and reliable wireless broadband services.

With that said, I look forward to hearing from our witnesses.

But before we do that, Mr. Chairman, I'd like to take a brief moment to address a question many have asked me following last week's announcement by FCC Chair-

man Pai that he intends to roll back the commission's net neutrality rules: Where do we, as lawmakers, go from here?

I certainly believe American consumers deserve better. They need to know that we have their back. And they deserve certainty and finality when it comes to their essential right to a truly free and open Internet protected by clear, enforceable net neutrality rules.

That lasting finality can only come from legislation, which is why I have been open to finding a true bipartisan solution on this issue. That solution cannot merely pay lip service to net neutrality, but must include real protections for consumers and empower the FCC with flexible, forward-looking authority over broadband providers.

But I'm not naïve. I have always said that net neutrality legislation would not happen overnight—even between members of goodwill who are not afraid to roll up their sleeves and tackle the issue. The reality we're facing right now is that there are too many folks—from Chairman Pai to stakeholders and lawmakers—that are dug in on this issue, making compromise an impossible task.

Mr. Chairman, I'm an optimist by nature but it's pretty clear to me that the climate isn't ripe at the moment for any negotiations that will lead to real, substantive legislation that could garner sufficient bipartisan support.

The CHAIRMAN. Thank you, Senator Nelson. And try we will. I think it's really important that Congress be heard from on this subject, and I think the actions being proposed by the FCC are, I believe, going to provide hopefully the necessary impetus for us to move forward with a legislative solution because, frankly, I think everybody here, we've batted this subject around a lot, realizes that the uncertainty created by constant lawsuits and changing administrations isn't something that's good for what has been a remarkable success story.

And the Internet and all that it's meant for our lives and our economy and the productivity that we see in the world today, we want to see that continued, we want to see that continued investment, and in order for that to happen, I think we've got to have certainty, and the best way to achieve that is through legislation. So I hope we can get there, and we're certainly committed to that end, and I'm glad to hear the Senator from Florida indicate that he is as well.

Let's proceed to our panel. And I want to start with Ms. Patricia Cooper, the Vice President of Satellite Government Affairs at SpaceX. She will be followed by Mr. Larry Downes, the Project Director for the Georgetown Center for Business and Public Policy; Mr. Brian Hendricks, who is the Head of Technology Policy and Public Affairs for the Americas Region for Nokia Corporation—this is a bit of a homecoming for Mr. Hendricks, who once served as the Committee's Republican Staff Director for my predecessor, Senator Kay Bailey Hutchison—the Honorable Jeff Weninger, who is a State Representative from the state of Arizona and has been doing some interesting work in this field; and the Honorable Gary Resnick, who, as Senator Nelson mentioned, is the Mayor of Wilton Manors in Florida, and so we're glad to have you back in front of this Committee.

A great panel. We'll start on my left, and your right, with Ms. Cooper. If you could confine your oral remarks to as close to 5 minutes as possible, it will enable us to get to questions, and we certainly want to give members of the Committee an opportunity to ask those.

So please proceed, Ms. Cooper.

**STATEMENT OF PATRICIA COOPER, VICE PRESIDENT,
SATELLITE GOVERNMENT AFFAIRS, SPACE EXPLORATION
TECHNOLOGIES CORP. (SPACE X)**

Ms. COOPER. Mr. Chairman, Ranking Member Nelson, and members of the Committee, thank you for the opportunity to participate in this important and obviously timely hearing. As this committee reviews barriers to broadband deployment, SpaceX appreciates your consideration of the capability that new U.S.-based satellite constellations operating close to the Earth can contribute to closing the digital divide.

In addition to my opening statement, I have prepared a detailed written statement, which I have submitted for the record.

Mr. Chairman, I am pleased to be here today representing SpaceX. As you know, SpaceX has from its inception leveraged American innovation, technical savvy, and an upstart culture to provide the most advanced launch and spacecraft systems in history.

With around 6,000 U.S.-based employees and a network of 4,400 suppliers nationwide, we are proud to provide a dependable and affordable ride to space for NASA, the Department of Defense, and the most sophisticated communications satellite operators in the world. Our innovation in launch technology has focused on achieving the "holy grail" of space access, reusability, and at the end of March, we successfully conducted the world's first reflight of an orbital-class rocket.

Looking forward, we intend to leverage our 15 years of experience toward a broadband satellite constellation. We plan to design, develop, produce, launch, and operate a constellation of 4,000 satellites. These will provide high-speed, low-latency, and affordable broadband to the underserved and unserved populations throughout the United States and abroad. This is an ambitious but vital objective.

This Committee knows well the broadband picture in our country today, with 34 million Americans without access to even basic broadband, 23 million of these in rural or remote areas, 41 percent of Americans living on tribal lands without broadband, and, importantly, more than half of connected Americans with only one available broadband service provider.

Today's hearing is about barriers to deployment, deploying broadband, in America. SpaceX believes that the next-generation satellite services will substantially alter the picture of broadband access and competition. My testimony will focus on the unique regulatory and spectrum-based barriers to bringing these systems online.

Let me briefly describe the SpaceX satellite system and how we think it can contribute to the broadband challenge. Initially, the SpaceX system will consist of 4,425 satellites operating close to the Earth with deployments starting in the next 5 years. On each spacecraft, we will apply cutting-edge space technologies that allow for spectrum reuse. The satellites in space will connect to user terminals on rooftops with gateways interconnected with the terrestrial Internet. In doing so, we will be able to bring services to homes, schools, or businesses with just a rooftop terminal a bit larger than a laptop.

In short, adding a new user will just require minimal ground infrastructure, helping to address that last mile, and alleviating the common terrestrial challenges of siting, digging trenches, laying fiber, and dealing with property rights.

So what hurdles do satellite systems face? First, regulations for these non-geostationary satellite constellations are in desperate need of modernization. The FCC has recognized this and is currently building a record to update the rules. We applaud this and encourage the Congress to monitor this effort and press for new rules that encourage innovation and reward spectrum-efficient constellations.

Second, SpaceX is concerned that spectrum use policies limit the potential for large constellations in space. Here, we recommend the government make, as a priority, access to key spectrum bands for these systems.

Third, we ask Congress to ensure technology neutrality when assessing broadband infrastructure initiatives generally. In the past, satellite was largely overlooked as a technology, even though it offers the widest geographic reach. Given the promise of the next generation of satellite broadband, we urge that satellite be qualified alongside their analogs with terrestrial and mobile systems in any broadband program.

Finally, in order to deploy large constellations, launch regulations at both the FCC and FAA need to be reformed. These regulations were written when commercial launches were rare. With commercial launch, and now landings, increasing in cadence to twice monthly and eventually weekly, it's time for an update.

At the FCC, spectrum for commercial launches is licensed through multiple short-term temporary authorizations per launch. For the last 4 years, the FCC has been working to provide an allocation which would, in turn, streamline the licensing process. We encourage Congress to support the FCC's launch spectrum rule-making and press them to finalize it.

At the FAA, regulations on commercial space launches also need to be modernized and streamlined. We applaud this committee for recently holding hearings on this issue, and we encourage you to continue efforts to ensure regulations keep pace with industry and not stifle innovation. We are excited about the promise our satellite constellation can bring.

Mr. Chairman, thank you again for the opportunity to here today. I will be pleased to answer any questions.

[The prepared statement of Ms. Cooper follows:]

PREPARED STATEMENT OF PATRICIA COOPER, VICE PRESIDENT, SATELLITE
GOVERNMENT AFFAIRS, SPACE EXPLORATION TECHNOLOGIES CORP. (SPACEX)

Mr. Chairman, Ranking Member Nelson, and Members of the Committee,

Thank you for the opportunity to participate in this important and timely hearing. As this Committee reviews broadband infrastructure investments, measures to streamline the regulatory process, and policy reforms to reduce barriers to expansion of broadband access in the United States, we are grateful that the Committee is considering the potential capability that a new generation of U.S.-based low-Earth orbit ("LEO") satellite broadband services can contribute to connectivity.

New technologies in space and on the ground, significant downward adjustments in satellite manufacturing costs, improved software and computing power, and dramatic reductions in the cost of space launch are all driving an era where large constellations of satellites orbiting close to the Earth can provide the high-speed, low-

latency Internet service that many consumers have come to expect. Moreover, these systems offer the potential to provide reliable, high-quality broadband service to areas of the United States and the world that have been underserved or not served at all. Such systems can help alleviate the inherent challenges of providing high-speed Internet to rural and “hard-to-reach” areas. Here, the geographic reach of satellite systems may obviate the need to build out the so-called “last mile” that, due to costs, environmental regulations, property rights issues, and other regulatory obstacles, starves so many communities of reliable, quality Internet access. Because of the significant up-front cost of a global satellite system, there is an inherent incentive to connect customers, no matter where they are. The satellites can “see” them whether they are urban or rural, and the incremental cost of adding a rural customer to a satellite network is so much lower than adding that rural customer to a ground-based cellular network.

Last November, SpaceX filed an application with the Federal Communications Commission (“FCC”) for a license to operate a new non-geostationary satellite orbit (“NGSO”) broadband Internet constellation, unveiling a development project we have been undertaking for nearly three years. While I will discuss some of the features of this system to help inform the Committee’s views with respect to the capabilities offered by next-generation broadband satellite constellations (*see* Section III), my testimony today will focus more broadly on the following policy areas, and potential barriers, to the expansion of broadband access in the United States:

- (1) The emergence of new technologies and cost structures that make large-scale, space-based broadband Internet services more viable today than ever before, and the potential such services could provide in expanding affordable access to high-speed broadband, including in rural, exurban, and suburban areas;
- (2) Efficient use of spectrum, and whether current regulatory frameworks provide the proper incentives for companies developing large constellations of satellites to invest in technologies that effectively share spectrum among these systems. The Committee should take proactive steps to encourage and reward companies that utilize and advance technologies that result in maximum spectrum sharing and efficiency;
- (3) The need to reconsider how current law, policy, and programs focused on expanding broadband access treat satellite systems, including a re-assessment of the potential data service and speeds offered, the application of “infrastructure” investments to space and ground systems, and subsidies for underserved consumers, school districts, rural health care providers, etc. for customer equipment. Here, it is timely to review how satellite broadband has improved and can contribute to the Nation’s connectivity goals, and how to incorporate such services into any national infrastructure initiative.
- (4) The need to streamline and modernize FCC and Federal Aviation Administration (“FAA”) regulations associated with commercial space launch, which today create barriers for emerging broadband satellite constellations from the United States, as well as degrade the U.S. space launch industrial base and its ability to be globally competitive.

SpaceX has, from the beginning, leveraged American innovation, technical savvy, and an upstart, iterative culture to provide the most advanced launch and spacecraft systems in history. We are proud to have contributed to providing a dependable and affordable ride to space for NASA, the Department of Defense, and the world’s most sophisticated commercial satellite manufacturers and operators. Today, we are regularly conducting cargo resupply missions to and from the International Space Station (“ISS”) with our Dragon spacecraft, and next year, we will launch the first American astronauts from U.S. soil on an American rocket since the Space Shuttle was retired in 2011.

SpaceX has restored the U.S. as a leader in global commercial satellite launch by percentage of market share. Looking forward, the company intends to leverage its fifteen years of experience in cost-effectively building and deploying large, complex space systems to support our broadband satellite constellation. With a vertically-integrated approach to this initiative—from design, development, production, launch, and operations—SpaceX is addressing many of the challenges that have stymied past attempts to achieve affordable, high-speed broadband from space.

I. SpaceX Today

Founded in 2002, SpaceX today is the world’s largest launch services provider, measured by missions under contract. We are an American firm that designs, manufactures, and launches rockets within the United States, with minimal reliance on foreign vendors or suppliers. SpaceX was founded with the express goal of dramati-

cally improving the reliability, safety, and affordability of space transportation. We have made that goal a reality.

The SpaceX Falcon 9 launch vehicle has now successfully launched 32 times, all while achieving evolutionary but significant reductions in the cost of space launch. To achieve revolutionary reductions in launch costs, which will contribute to our ability to rapidly and cost-effectively deploy our broadband satellite constellation, SpaceX has focused on making our rockets reusable. Last month, SpaceX successfully launched and landed a previously-flown Falcon 9 booster, placing a high-value telecommunications satellite into orbit for SES, a global satellite operator.

SpaceX has nearly 70 missions on manifest, representing more than \$10 billion in signed contracts for a diverse and growing set of customers, including NASA, the Department of Defense, commercial satellite operators, and allied international governments. SpaceX has a healthy, robust business; as technology companies should, we invest much of our profits back into the company's manufacturing and launch infrastructure and into advanced research and development, including satellite and ground system development.

Meanwhile, we continue to push ahead on rocket technology developments and innovations as we advance toward fully and rapidly reusable launch vehicles; design and fly, with Dragon, the safest crew transportation system ever produced for American astronauts for NASA; and develop and produce the initial prototypes for our broadband satellite system for initial launch by the end this year. Critically, all of this innovation is occurring in the United States, creating jobs, advancing technology, and generating substantial economic activity.

SpaceX maintains its manufacturing and engineering headquarters in Hawthorne, CA; a satellite system design and development office in Redmond, WA; a Rocket Development and Test Facility in McGregor, TX; and launch pads at Cape Canaveral Air Force Station, NASA Kennedy Space Center, Vandenberg Air Force Base, and, soon, a commercial launch site near Brownsville, TX. SpaceX maintains a network of more than 4,400 American suppliers and partners—an investment in the American industrial base when others are spending abroad.

II. Disparities in Broadband Availability & Quality: A Market Opportunity

SpaceX sees substantial demand for high-speed broadband in the United States and worldwide. As the Committee is aware, millions of Americans outside of limited urban areas lack basic, reliable access. Furthermore, even in urban areas, a majority of Americans lacks more than a single fixed broadband provider from which to choose and may seek additional competitive options for high-speed service.¹

According to the FCC, thirty-four million Americans lack access to 25 megabits per second (“Mbps”) broadband service, and 47 percent of the Nation’s students lack the connectivity to meet the FCC’s short-term goal of 100 Mbps per 1,000 students and staff. As the FCC has noted:

there continues to be a significant disparity of access to advanced telecommunications capability across America with more than 39 percent of Americans living in rural areas lacking access to advanced telecommunications capability, as compared to 4 percent of Americans living in urban areas, and approximately 41 percent of Americans living on Tribal lands lacking access to advanced telecommunications capability.²

While more than twenty-three million Americans living in rural areas account for the majority of those who lack access, nearly ten million Americans living in non-rural areas also lack basic access to high-speed Internet service. As this Committee well knows, the U.S. lags behind other developed nations in both its broadband speed and in price competitiveness, and many rural areas are simply not served by traditional broadband providers due to the high capital expenditure required for last-mile infrastructure relative to low revenue opportunities.

At the same time, worldwide demand for broadband services and Internet connectivity continues to grow, with consumers increasing their requirements for speed, capacity, and reliability. The volume of traffic flowing over the world’s networks continues to skyrocket, with one vendor estimating that annual global Internet Protocol (“IP”) traffic surpassed the zettabyte threshold in 2016—meaning that

¹Federal Communications Commission, *2016 Broadband Progress Report*, (January 28, 2016), GN Docket No. 15–191, available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-16-6A1.pdf.

²*Ibid.*

over 1,000 billion gigabytes of data was exchanged worldwide last year.³ By 2020, that figure is projected to more than double (reaching a level nearly 100 times greater than the global IP traffic in 2005), global fixed broadband speeds will nearly double, and the number of devices connected to IP networks will be three times as high as the global population.

As consumer demands on speed and capacity continue to grow, disparities in access and competitive choice persist for many communities. Many consumers who have access to broadband today lack the multiplicity of choice that robust, competitive marketplaces tend to offer. The FCC has found that “only 38 percent of Americans have more than one choice of providers for fixed advanced telecommunications capability,” with only “13 percent of Americans living in rural areas having more than one choice of providers of these services compared to 44 percent of Americans living in urban areas.”⁴

In large measure, the disparity in available service to rural and “hard-to-reach” areas is the result of the heavy, up-front capital expenditures necessary to achieve connectivity to these locations. Further, regulatory hurdles and the general pace of regulatory approvals in the U.S. associated with siting broadband infrastructure and securing environmental approvals continue to pose challenges. According to the Government Accountability Office (“GAO”):

Access to affordable broadband telecommunications is vital to economic growth and improved quality of life across the country. In rural areas in particular, broadband can serve to reduce the isolation of remote communities and individuals. The provision of broadband Internet infrastructure and services in the United States is generally privately financed. However, rural areas can have attributes that increase the cost of broadband deployment, such as remote areas with challenging terrain, or make it difficult to recoup deployment costs, such as relatively low population densities or incomes. These attributes can decrease the likelihood that a broadband service provider will build out or maintain a network in a rural area. For these reasons, some rural areas lag behind urban and suburban areas in broadband deployment or service speed.⁵

Despite a diverse set of technology platforms currently serving the ever-growing demand for broadband, from terrestrial fiber and cable systems to mobile cellular networks and, to a lesser degree, space-based systems, many parts of the United States and the world lack access to reliable broadband connectivity. However, next-generation satellite systems operating in orbits close to the Earth, with innovative technologies to provide rapid data rates and minimal latency, may offer a way around this gap in broadband access in the United States.

Beyond the United States, the United Nations Broadband Commission for Sustainable Development recently noted that 4.2 billion people, or 57 percent of the world’s population, are simply “offline” for a wide range of reasons—but predominantly because the necessary connectivity is not present or not affordable.⁶ As the Committee knows, access to broadband and communications technologies are key to economic growth, social stability, access to healthcare, education, and basic services, particularly in lesser-developed countries.

In numerous ways, satellite technology has long helped to alleviate inequities in the availability of communications services, in part due to its geographic reach. Historically, satellites first revolutionized the availability of international telephony, then pioneered global distribution of video content. More recently, satellite systems have introduced broadband connectivity for mobile platforms, such as aircraft and ships—establishing and supporting new markets and enhancing those businesses and their customer experience.

³Cisco Visual Networking Index: Forecast and Methodology, 2015–2020, at 1 (June 6, 2016), available at <http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/complete-white-paper-c11-481360.pdf>; see also <http://blogs.cisco.com/sp/happy-zettabyte-day-2016>. To fathom the volume of a zettabyte, if one byte is a litter, then a zettabyte is the equivalent of 7080 Pacific Oceans. See *id.*

⁴FCC, *2016 Broadband Progress Report*.

⁵U.S. Government Accountability Office, *Rural Broadband Deployment: Improved Consistency with Leading Practices Could Enhance Management of Loan and Grant Programs*, (April 2017), GAO–17–301, available at <http://www.gao.gov/assets/690/684093.pdf>.

⁶Broadband Commission for Sustainable Development, “Open Statement from the Broadband Commission for Sustainable Development to the UN High-Level Political Forum (HLPF)” (July 11, 2016), available at <http://broadbandcommission.org/Documents/publications/HLPF-July2016.pdf>.

III. SpaceX's Proposed Satellite Architecture—Broadband from Space

SpaceX plans to bring high-speed, reliable, and affordable broadband service to consumers in the U.S. and around the world, including areas underserved or currently unserved by existing networks. Other companies have also recently announced plans for large-scale broadband satellite constellations, with the FCC currently undertaking a processing round considering the applications of a number of potential licensees requesting authority to operate in the United States.

For our part, we will apply cutting-edge space technologies and spectrum re-use approaches, while leveraging our unique space-based design, manufacturing, launch, and space operations experience. Specifically, technology advancements like dynamic beam forming and phased array antennas in space and on the ground, as well as optical inter-satellite links to establish a “mesh network” in space through which the satellites will communicate with each other, enhance the capacity and customer experience for broadband satellite service.

Initially, the SpaceX system will consist of 4,425 satellites operating in 83 orbital planes (at altitudes ranging from 1,110 km to 1,325 km). This system will also require associated ground control facilities, gateway earth stations, and end user earth stations.⁷ Using Ka- and Ku-Band spectrum, the initial system is designed to provide a wide range of broadband and communications services for residential, commercial, institutional, governmental, and professional users worldwide. SpaceX has separately filed for authority to operate in the V-Band, where we have proposed an additional constellation of 7,500 satellites operating even closer to Earth. In the future, these satellites will provide additional broadband capacity to the SpaceX system and further reduce latency where populations are heavily concentrated.⁸

To implement the system, SpaceX will utilize the availability of significantly more powerful computing and software capabilities, which will enable SpaceX to allocate broadband resources in real time, placing capacity where it is most needed and directing energy away from areas where it might cause interference to other systems, either in space or on the ground. Because the satellites will beam directly to gateways or user terminals, the infrastructure needed on the ground—particularly in rural or remote areas—is substantially reduced, essentially addressing the “last mile” challenge and helping to close the digital divide. In other words, the common challenges associated with siting, digging trenches, laying fiber, and dealing with property rights are materially alleviated through a space-based broadband network.

SpaceX intends to continually iterate and improve the technology in the system, something that our satellite manufacturing cost profile and in-house launch capability uniquely enables. The ability to modify service as necessary, as well as refresh the technology of the satellite system through iterative spacecraft design changes and phased, continuous deployment, is critical to meet rapidly changing customer demands and responsibly utilize spectrum. This approach will ensure that the system remains adaptable to existing and future customer demands.

For the end consumer, SpaceX user terminals—essentially, a relatively small flat panel, roughly the size of a laptop—will use similar phased array technologies to allow for highly directive, steered antenna beams that track the system’s low-Earth orbit satellites. In space, the satellites will communicate with each other using optical inter-satellite links, in effect creating a “mesh network” flying overhead that will enable seamless network management and continuity of service. The inter-satellite links will further help SpaceX comply with national and international rules associated with spectrum sharing, which distinguishes our system from some of the other proposed NGSO constellations.

Overall, SpaceX has designed our system to achieve the following key objectives:

- (1) *Capacity.* By combining the umbrella coverage of the LEO Constellation with the more intensive coverage from the VLEO Constellation, the SpaceX System will be able to provide high volume broadband capacity over a wide area. SpaceX will periodically improve the satellites over the course of the multi-year deployment of the system, which may further increase capacity.
- (2) *Adaptability.* The system leverages phased array technology to steer dynamically a large pool of beams to focus capacity where it is needed. As noted, optical inter-satellite links will permit flexible routing of traffic on-orbit. Further, the constellation ensures that a variety frequencies can be reused effectively

⁷ Space Exploration Holdings, LLC, *Application for Approval for Orbital Deployment and Operation Authority for the SpaceX NGSO Satellite System* (November 15, 2016), Before the Federal Communications Commission, IBFS File No. SAT-LOA-20161115-00118.

⁸ Space Exploration Holdings, LLC, *Application for Approval for Orbital Deployment and Operating Authority for the SpaceX NGSO Satellite System* (March 1, 2017), Before the Federal Communications Commission, IBFS File No. SAT-LOA-20170301-00027.

across different satellites to enhance the flexibility, capacity and robustness of the overall system.

- (3) *Broadband Services.* The system will be able to provide broadband service at fiber-like speeds, the system's use of low-Earth orbits will allow it to target latencies comparable to terrestrial alternatives. SpaceX intends to market different packages of data at different price points, accommodating a variety of consumer demands.
- (4) *Efficiency.* SpaceX is designing the system from the ground up with cost-effectiveness and reliability in mind, from the design and manufacturing of the space and ground-based elements, to the launch and deployment of the system using SpaceX launch services, development of the user terminals, and end-user subscription rates.

Later this year, SpaceX will begin the process of testing the satellites themselves, launching one prototype before the end of the year and another during the early months of 2018. Following successful demonstration of the technology, SpaceX intends to begin the operational satellite launch campaign in 2019. The remaining satellites in the constellation will be launched in phases through 2024, when the system will reach full capacity with the Ka- and Ku-Band satellites. SpaceX intends to launch the system onboard our Falcon 9 rocket, leveraging significant launch cost savings afforded by the first stage reusability now demonstrated with the vehicle.

IV. Barriers to the Expansion of Broadband from Satellite Systems: Policy Recommendations for the Committee

As the Committee considers policy action that could facilitate the expansion of broadband access in the United States, SpaceX respectfully offers the following recommendations for satellite infrastructure:

Regulations for NGSO Systems Need Modernization. Congress should support the FCC's ongoing efforts to modernize certain regulations relating to NGSO satellite systems, which were originally developed nearly two decades ago and in many cases are outmoded given modern satellite system technology and market conditions. For example, current FCC rules require an NGSO licensee to launch all satellites in its constellation within six years of receiving a license. While this may have been desirable in the past, this artificial timeline inhibits the organic growth of large satellite constellations, preventing them from growing with the market to respond to consumer demand. Instead, these systems should be allowed to grow more like cellular networks, where additional assets and updated technology are deployed over time to meet increased demand.

Moreover, in the case of large constellations like SpaceX's, the system is brought into operation with far fewer satellites, with additional satellites launched to add capacity and meet market demand as it evolves. As such, companies investing in a multi-year deployment strategy should not be penalized for enhancing their system over time. The FCC is currently conducting a rulemaking to modernize its satellite rules, especially those applicable to NGSO systems, which we hope will yield a regulatory regime more consistent with current market and technology realities.⁹ Should the FCC not proceed quickly in addressing these issues, the Committee should support waivers to ensure these innovative broadband systems are not artificially constrained.

Next Generation Satellite Systems are Broadband Infrastructure and should be Included in any Infrastructure Legislation. The expansion of satellite broadband through U.S.-based constellations is, fundamentally, a national infrastructure project, even though many components of the infrastructure will be in space. In prior investment rounds and through funds like the Universal Service Fund ("USF"), satellite broadband was often an afterthought. For example, of the \$6.9 billion awarded for broadband infrastructure through National Telecommunications and Information Administration's ("NTIA") Broadband Technology Opportunities Program ("BTOP") and the U.S. Department of Agriculture's Rural Utilities Service ("RUS"), only approximately \$100 million went to satellite systems, or less than 1.5 percent of all funds appropriated.¹⁰ In many ways, this was the result of limitations

⁹ *Updates to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, 31 FCC Red. 13651 (2016) ("NPRM").

¹⁰ National Telecommunications and Information Administration, U.S. Department of Commerce, Broadband Technology Opportunities Program (BTOP) Quarterly Program Status Report (March 2017), available at https://www.ntia.doc.gov/files/ntia/publications/ntia_btop_31st_qtrly_report.pdf; and U.S. Department of Agriculture, Rural Utilities Service, Broadband Initiatives Program Final Report (December 2016), available at https://www.rd.usda.gov/files/reports/RUS_BIP_Status_FinalReportDec_2016.pdf.

at the time on satellite capacity, high latency rates due to satellite distance from the Earth, and relatively slow data rates compared to terrestrial and mobile networks. It was also related to a general failure of imagination to make investment and subsidy structures applicable to satellite infrastructure and consumer hardware, since satellite systems have few “shovels in the ground.”

However, as satellite-based broadband achieves speeds, latencies, and pricing equivalent to terrestrial and 5G wireless technologies, it becomes especially critical for Congress and Federal agencies to reconsider how these systems can participate in national infrastructure investment programs and other Federal initiatives to close the digital divide. Infrastructure associated with a satellite broadband system includes launch facilities, consumer terminals that are placed on homes or businesses, gateways that will be placed at potentially hundreds of Internet points of presence (“PoPs”) throughout the United States that are used to route traffic, large antennas to track and control the satellites in space, and satellite operations centers. The satellites themselves are essentially infrastructure in the sky, a network that is not dissimilar to cell towers or underground fiber.

As such, SpaceX encourages the Committee to take steps to ensure that broadband satellite system infrastructure is duly captured in any infrastructure, incentive, or tax policy legislation undertaken to expand broadband access in the United States. Such an approach will not only ensure that Congress and regulatory agencies maintain a technology-neutral approach, but it will also ensure the U.S. Government and American consumers are positioned to benefit from the significant innovations and great promise of that satellite systems are poised to bring.

Systems and Technology that Achieve Spectrum Efficiency Should be Rewarded. The new generation of broadband NGSO constellations holds incredible potential to bring affordable, fiber-like broadband services to underserved and unserved areas of the United States. Investment in advanced technologies that provide spectral efficiency and operational flexibility are necessary for NGSO systems to increase access to reliable, high-speed broadband connectivity. Unfortunately, not all operators have chosen to make the investment necessary to include many of these technologies in their proposed systems. As a result, some systems would not only make inefficient use of the spectrum they seek to use, but also may prevent other NGSO systems from efficiently sharing the available spectrum.

As such, the Committee should ensure that the FCC takes steps to incentivize and reward efficient spectrum sharing. Spectrum sharing policies should ensure that all systems have equitable access to spectrum, avoid any warehousing of spectrum by non-operating systems, and incorporate sufficient flexibility to promote and accommodate spectrum coordination among operating systems. Given the advent of new space-based and ground technologies, spectrum sharing is most efficiently managed by using highly intelligent and flexible satellites, as this expands the range of potential sharing strategies available to the operators involved.

Congress should encourage regulatory authorities to adopt rules that create incentives that encourage the use of spectrally-efficient technologies. Spectrum is a valuable and increasingly scarce resource, which must be shared by multiple satellite and terrestrial systems. Licensing inefficient NGSO systems, or granting such systems access to the U.S. market, not only imposes a burden on more efficient systems, but also undermines the national interest in promoting efficient usage of spectrum and maximizing broadband service to the public. Yet at present, the FCC has no mechanism for rewarding more efficient systems for their investment in advanced and spectrum-friendly technologies. If Congress wants to ensure that valuable spectrum resources are put to intensive and efficient use, it should encourage the FCC to implement policies that reward NGSO spectral efficiency when making public interest determinations.

Spectrum Use Policy in the Ka- and V-Bands Should be Revised. SpaceX is concerned about FCC spectrum use policies that enable NGSO constellations, specifically in Ka- and V-bands. FCC rules effective today were written over a decade ago, and did not envision the potential of large constellations operating in low Earth orbit. As a result, these constellations are unduly restricted from using important segments of spectrum as compared to ground-based fixed systems. While the agency has granted waivers for NGSO systems to operate in parts of this spectrum on an unprotected, non-interference basis, this approach is not sustainable over the long-term, especially as these new systems come online. To partially remedy this challenge, FCC has released a Notice of Proposed Rulemaking (“NPRM”) that would make an additional 1.3 GHz of Ka-band spectrum available for NGSO use, a positive development that SpaceX encourages the Committee to support. In addition, FCC should further remove impediments to NGSO use of 4.5 GHz of V-band spectrum (37.5–40.0/50.4–52.4 GHz), a step that would make U.S. spectrum rules more consistent with existing international allocations for use.

FCC Commercial Launch Spectrum Licensing Process Should be Streamlined. For four years, the FCC has been considering a Notice of Proposed Rulemaking (“NPRM”) that would make available a limited range of frequencies in the Federal spectrum band that are commonly used for commercial launch available to the commercial sector on a co-primary basis.¹¹ The FCC proposed moving away from approving commercial launch spectrum grants under Special Temporary Authorizations (“STA”), which are handled on an individual basis and remain in effect for a short period of time, to a more streamlined approach that reduces paperwork and regulatory burden. We encourage the Committee to support the pending NPRM, to enable the FCC to better manage spectrum allocations for commercial launch spectrum. This effort is a timely and important step for the Commission to adjust to the increasing cadence and complexity of launches and growth in number of U.S. launch service providers.

FAA Commercial Launch License Regulations Require Modernization. Aside from issues relating to spectrum and broadband policy specifically, SpaceX is also working with this Committee, and others, through its Subcommittee on Space, on an important effort to modernize and streamline the FAA regulations governing commercial space launch. These regulations were promulgated in a time when commercial spaces launches were rare, and launch was primarily the domain of the U.S. Government. However, as the industry transitions from a pace of a few commercial launches per year to a launch per week, or more, in the near future, it is essential that FAA regulations be updated to avoid obstructing industry growth and innovation in the U.S. domestic commercial space launch industry.

Mr. Chairman, I appreciate your invitation to testify before the Committee today. SpaceX looks forward to being part of the solution to expand access to high-speed, reliable, and affordable broadband Internet connectivity in the United States and worldwide. If we can answer any questions or provide any additional information, please contact Mat Dunn at mat@spacex.com.

The CHAIRMAN. Thank you, Ms. Cooper.
Mr. Downes.

**STATEMENT OF LARRY DOWNES, PROJECT DIRECTOR,
GEORGETOWN CENTER FOR BUSINESS AND PUBLIC POLICY**

Mr. DOWNES. Well, thank you and good morning, Mr. Chairman, Ranking Member Nelson, and members of this committee. I am grateful for the opportunity to testify this morning before you on barriers to broadband adoption and deployment on an accelerated base, based in Silicon Valley, by the way. I am also the author of several books, on the information economy, innovation, and the impact of regulation on the speed and trajectory of technology innovation.

Let me start with some good news. Twenty years into the Internet revolution, the U.S. continues to dominate global markets for disruptive innovation, in large part, because of farsighted bipartisan policies from this committee and others. If we stay this course, future investments will make possible a new wave of innovation in everything from autonomous vehicles to smart cities, virtual reality, on-demand manufacturing, artificial intelligence, among many others.

But as the saying goes, the future is already here, it’s just not very evenly distributed. Driven by a combination of geographic, demographic, and educational factors, today’s digital have-nots are

¹¹ *Amendment of Part 2 of the Commission’s Rules for Federal Earth Stations Communicating with Non-Federal Fixed Satellite Service Space Stations; Federal Space Station Use of the 399.9–400.05 MHz Band; and Allocation of Spectrum for Non-Federal Space Launch Operations*, (May 9, 2013), ET Docket No. 13–115, RM–11341 (“NPRM”), available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-13-65A1_Red.pdf.

characterized, not by their race, sex, or income so much as by where they live. Americans in rural and tribal lands, as well as seniors and those with less education, are now the groups disproportionately disconnected from our increasingly important digital conversation, and we are all worse off for their absence.

To close that gap, and in the spirit of nonpartisan cooperation, Blair Levin and I recently reviewed the history of U.S. broadband deployment and developed eight specific recommendations for future infrastructure legislation. Levin, as this committee knows, directed the visionary National Broadband Plan, perhaps the most cost effective investment of the entire 2009 stimulus bill.

Now, these recommendations are hardly original. Well, they probably are in terms of Blair, but none of them are controversial. And, happily, many of the best ideas would cost little or nothing in taxpayer dollars, but they do require your leadership to break longstanding logjams across government.

In considering how best and most effective to close this remaining availability and adoption gap, my overall advice to this committee is to learn from the success and failure of previous Federal and local efforts, notably the 2009 American Recovery and Reinvestment Act.

The bottom line here is simple. Accelerating deployment and adoption of broadband infrastructure for disconnected Americans will require some Federal spending, but the spending needs to be done in a more focused and professional way than in the past to reach those who truly need help. And those efforts can be multiplied by encouraging the update of state and local processes, which in turn, will provide incentives for private investors to reallocate even more of their own capital in ways that ultimately benefit everyone.

Let me just very briefly list our specific recommendations, which I describe in my written testimony in the record.

Number one is to limit and carefully control direct investments. We suggest creating a broadband acceleration fund, but use it only in areas where there is currently no provider. We want to determine the need of subsidies on a per-area basis and have one agency, preferably the FCC, be the sole administrator. And we suggest using general appropriations to fund that program rather than increases to the universal service fee.

Second is to severely limit ongoing support. We want to change the paradigm of small capital support with uncertain ongoing operating subsidies to one that strongly favors areas where initial capital would be sufficient to overcome excessively high costs, and then use reverse auctions to maximize the bang for taxpayer buck in those areas.

And number three, extend "Dig Once." This committee has already looked at this and has made great progress. We agree ensuring broadband conduit is installed whenever Federal roads are dug up for any reason, and to the extent possible, extending that policy to state roads and rights-of-way.

Number four, address other unproductive barriers to mobile deployment. While local authorities, of course, continue to ensure public safety and other local interests, most of what slows down installation of new equipment promotes no public interest; in fact,

quite the opposite. Treating small cell and tent installation on utility poles and buildings, for example, as if they were full-scale tower builds really serves no public goal. Shot clocks, uniform pole attachment policies, and other best practices should be established I think at the Federal level.

Number five, reengineer government processes that hinder private investment. Many local processes for application review and inspection are ad hoc, creating unneeded delays and costs that hold back deployment for both wired and mobile builds of next-generation networks. These must be standardized. The problem is not local regulation so much as local process or really the lack thereof.

Number six, make investments technology-neutral. Next-generation mobile networks and satellite-based solutions, as you just heard, they will be truly competitive in both speed and reliability, with fiber, cable, and copper hybrid technologies, which are also improving. So Federal programs, including Lifeline, should encourage development and deployment of all broadband technologies.

Number seven, address non-financial causes of the digital divide. Availability in price have really largely been solved through public and private solutions. Surveys now consistently show that those who remain part of the digital divide, again, rural, senior, and less educated Americans, are unlikely to take broadband at any price. Public education about the relevance of broadband and training in basic computer usage may not cost much, but without them, any money spent will at least be partly wasted.

And then, finally, use the bully pulpit to encourage digital want-nots. The National Broadband Plan laid out a vision of America's broadband future, which has largely come to be, or will soon, but neither the White House nor the FCC communicated that vision to digital want-nots. The FCC should take an updated plan on the road along with startups and established companies who are making the vision a reality.

Now, in Silicon Valley, this is what we call a win-win-win, and I'm happy to expand on any of these points and look forward to your questions. Thank you very much.

[The prepared statement of Mr. Downes follows:]

PREPARED STATEMENT OF LARRY DOWNES,¹ PROJECT DIRECTOR,
GEORGETOWN CENTER FOR BUSINESS AND PUBLIC POLICY

Chairman Thune, Ranking Member Nelson and members of the Committee, thank you for this opportunity to testify on barriers to accelerated broadband deployment.

My name is Larry Downes. Based in Silicon Valley, I am Project Director at the Georgetown Center for Business and Public Policy and the author of several books on the information economy, innovation, and the impact of regulation on the speed and trajectory of technology innovation.

Summary

Let's start with some good news. Twenty years into the Internet revolution, the U.S. continues to dominate a global market for disruptive innovation, in large part because of far-sighted bi-partisan policies. In particular, broadband-related legislation over the last two decades—including the 1996 Communications Act, Section 230 of the Communications Decency Act, the American Recovery and Reinvestment Act

¹Larry Downes is Project Director at the Georgetown Center for Business and Public Policy. His books include *Big Bang Disruption: Strategy in an Age of Devastating Innovation* (Portfolio, 2014), *Unleashing the Killer App* (Harvard Business School Press, 1998), *The Laws of Disruption* (Basic Books, 2009).

of 2009 and the Spectrum Act of 2012—have encapsulated some of the most successful technology policies ever adopted.

In response, U.S. network developers have built the world’s most extensive wired and wireless broadband infrastructure. Competing providers are now racing to build next-generation networks, including gigabit Internet over fiber, cable and hybrid networks and ultra-high speed 5G mobile networks. And in keeping with recommendations of the visionary 2010 National Broadband Plan, almost all of this new investment has been privately funded.

Ubiquitous high-speed Internet has meant that every industry my colleagues and I have studied is in the midst of or about to be dramatically changed for the better.² If we stay the course, future investments will make possible a new wave of innovation in everything from autonomous vehicles to smart cities, virtual reality, on-demand manufacturing, and artificial intelligence, among many others.

But the broadband revolution has yet to reach some of our most at-risk communities and remote geographies. As science fiction writer William Gibson famously said, “The future is already here, it’s just not very evenly distributed.” Though we may disagree about the metrics for determining acceptable speeds, latency and technology platforms for what constitutes broadband service, no one can deny that a significant digital divide still exists in the U.S.

Driven by a combination of geographic, demographic and educational factors, today’s digital have-nots are characterized not by their race, sex, or income but by where they live. Americans living in rural and tribal lands, as well as seniors and those with less education, are now the groups disproportionately disconnected from our increasingly important digital conversation. And we are all worse off for their absence.³

Though our public and utility infrastructure, which just received an overall grade of “D+” from the American Society of Civil Engineers,⁴ should clearly be the focus of the most urgent and sustained attention, there is also broad agreement that targeted Congressional action can accelerate the continued deployment and adoption of broadband technologies, closing what remains of our digital divide.⁵

In the spirit of non-partisan cooperation, Blair Levin and I recently reviewed the history of U.S. broadband deployment and developed eight specific recommendations for future infrastructure legislation.⁶ Levin, as this Committee knows, directed the visionary National Broadband Plan—perhaps the most cost-effective investment of the entire stimulus bill—and now serves as a senior fellow at the Brookings Institution.

These recommendations are hardly original—well, they probably are to Blair. But in any event, they are not controversial. Some of them have already been presented

²Larry Downes and Paul Nunes, “Big-Bang Disruption,” *Harvard Business Review* (March, 2013), pp. 44–56, available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2709801.

³Blair Levin and Larry Downes, *A New Digital Divide has Emerged—and Conventional Solutions Won’t Bridge the Gap*, THE WASHINGTON POST, Oct. 14, 2016, available at https://www.washingtonpost.com/news/innovations/wp/2016/10/14/a-new-digital-divide-has-emerged-and-conventional-solutions-wont-bridge-the-gap/?utm_term=.882707eba100. See also National Telecommunications and Information Administration, *Digitally Unconnected in the U.S. Who’s Not Online and Why?*, Sept. 28, 2016, available at www.ntia.doc.gov/blog/2016/digitally-unconnected-us-who-s-not-online-and-why; Monica Anderson and Andrew Perrin, *13 percent of Americans Don’t Use the Internet—Who are They?*, Pew Research Report, Sept. 7, 2016, available at <http://www.pewresearch.org/fact-tank/2016/09/07/some-americans-dont-use-the-internet-who-are-they/>; Larry Downes, *The Digital Revolution has not Reached All of Us*, THE WASHINGTON POST, Aug. 31, 2016, available at https://www.washingtonpost.com/news/innovations/wp/2016/08/31/the-internet-revolution-has-not-reached-all-of-us/?utm_term=.dd4ffcefd9d9.

⁴See American Society of Civil Engineers, *2017 Infrastructure Report Card*, available at <http://www.infrastructurereportcard.org/>.

⁵As the White House and Congress develop an infrastructure plan promised during the campaign, many, including Senators, House Members and mayors, are urging that broadband be included. See, e.g., Klobuchar, Capito, King, Heitkamp, Boozman Lead 48 Senators in Urging President Trump to Include Broadband in Any Infrastructure Initiative, January 31, 2017, available at <https://www.klobuchar.senate.gov/public/index.cfm/news-releases?ID=A5F09FAD-1223-4B0C-A058-80DDD0A9AF09>; Letter to President Donald Trump, Jan. 30, 2017, available at <http://welch.house.gov/sites/welch.house.gov/files/Telecom%202017.01.30%20Letter%20to%20Pres%20Trump%20re.%20broadband.0.pdf>; Next Century Cities, *Over 60 Mayors and Municipal Leaders Send Letter Calling on Congress to Include Broadband in Infrastructure Plans*, March 1, 2017, available at <http://nextcenturycities.org/2017/03/01/over-60-mayors-and-municipal-leaders-send-letter-calling-on-congress-to-include-broadband-in-infrastructure-plans/>.

⁶Blair Levin and Larry Downes, *Should Broadband Be Included in the Trump Infrastructure Plan?*, THE WASHINGTON POST, April 5, 2017, available at https://www.washingtonpost.com/news/the-switch/wp/2017/04/05/should-broadband-be-included-in-the-trump-infrastructure-plan/?utm_term=.a1d904f5fcee.

to this Committee in response to your request for recommendations. Others have been offered in various forms by analysts across the political spectrum.⁷

Still more specific, common-sense reforms have now been proposed by the FCC in several infrastructure-related Notices approved without dissent at the Commission's most recent meeting.⁸ Others, including freeing up critical radio spectrum currently licensed to the Federal Government, are part of the proposed MOBILE NOW Act.

Happily, many of the best ideas would cost little or nothing in taxpayer dollars. But they do require your leadership to break long-standing logjams across government.

In considering how best and most effectively to close the remaining availability and adoption gaps, my overall advice to this Committee is to learn from the successes and failures of previous Federal and local efforts, notably the 2009 American Recovery and Reinvestment Act—the last major Federal investment in infrastructure rebuilding and expansion.⁹

Many of the broadband-related initiatives in the stimulus bill significantly improved broadband availability for those living in rural, mountain and tribal areas, where competitive private investment for ultra-high speed wired infrastructure remains difficult to cost-justify. But there is also little argument that, due not to cost but to poor management and unfocused objectives, far too much of the billions in stimulus dollars committed to this effort failed to help anyone.¹⁰

The bottom line is simple: Accelerating deployment and adoption of broadband infrastructure for disconnected Americans will require some Federal spending. But the spending needs to be done in a more focused and professional way than in the past to reach those who really need help.

And those efforts can be multiplied by encouraging the update of state and local processes, which in turn will provide incentives for private investors to reallocate their own capital in ways that ultimately benefit everyone.

Recommendations

1. *Limit and carefully control direct investments.* Any direct infrastructure spending Congress approves should be targeted exclusively to the few remaining census tracts, mostly rural and tribal, where there is currently no competitive broadband service. Congress should consider setting aside a modest portion of its proposed infrastructure fund, say \$20 billion, for a one-time rural broadband acceleration program.

Network operators would be offered subsidies to build out in these extremely high-cost areas, with a requirement to use technologies with sufficient bandwidth to support substantial future growth, perhaps up to 100 Mbps speeds. Calculation of specific subsidies should be made on a per-location basis, determining as precisely as possible how much is needed to overcome otherwise prohibitive build-out costs.

Funds for the acceleration program, moreover, should come from general appropriations rather than raising the already-unustainable fees consumers pay into the Universal Service Fund, which today represents a 17.4 percent cost added to voice services.¹¹

To avoid problems that plagued the Recovery Act's scattered broadband initiatives, moreover, the acceleration program should be managed by one agency,

⁷ See, e.g., Doug Brake, *A Policymaker's Guide to Rural Broadband Infrastructure*, Information Technology and Innovation Foundation (April 2017), available at http://www2.itif.org/2017-rural-broadband-infrastructure.pdf?mc_cid=4fb4705a17&mc_eid=98756dc702; Blair Levin and Carol Matthey *In Infrastructure Plan, a Big Opening for Rural Broadband*, Brookings Institution, Feb. 13, 2017, available at, <https://www.brookings.edu/blog/the-avenue/2017/02/13/in-infrastructure-plan-a-big-opening-for-rural-broadband/>.

⁸ See FCC, *April, 2017 Open Commission Meeting*, April 20, 2017, available at <https://www.fcc.gov/news-events/events/2017/04/april-2017-open-commission-meeting>. (Statements of Comm. Clyburn, concurring)

⁹ H.R. 1—111th Congress: American Recovery and Reinvestment Act of 2009.

¹⁰ See, e.g., Testimony of Ann C. Eilers, Principal Assistant Inspector General, DOC OIG before the House Energy & Commerce Committee's Subcommittee on Communications and Technology, *Is the broadband stimulus working?*, Feb. 27, 2013, available at <https://www.oig.doc.gov/OIGPublications/OIG-13-017-T.pdf>; Government Accountability Office, *Recovery Act: USDA Should Include Broadband Programs Impact in Annual Performance Reports*, June, 2014 at page 22; Tony Romm, *Wired to Fail*, POLITICO, July 28, 2015, available at <http://www.politico.com/story/2015/07/broadband-coverage-rural-area-fund-mishandled-120601>.

¹¹ See FCC, *Contribution Factor and Quarterly Filings—Universal Service Fund Management Support*, available at <https://www.fcc.gov/general/contribution-factor-quarterly-filings-universal-service-fund-usf-management-support>.

with strict controls to help ensure troubled projects get attention (or cut off) sooner rather than later. Between the National Telecommunications and Information Administration, Rural Utilities Service, and the FCC, there is consensus that the FCC does the best job at maximizing its deployment-related funds, and should be the sole agency responsible for the acceleration fund, albeit with added controls to reduce waste and abuse.

2. *Severely limit ongoing support.* To date, Federal efforts to overcome the financial hurdles to deploying rural broadband infrastructure have suffered from a structural flaw. The FCC provides payments in the form of small ongoing annual subsidies, even in areas when all that was needed to overcome high infrastructure costs was an initial capital investment. Because of this approach, it can take years for providers to recoup their own capital investments, unintentionally encouraging operators to build piecemeal in rural areas, and to make decisions based on what providers believe the government will fund rather than on what consumers want.

Future investments should avoid this error by offering instead carefully-calculated one-time subsidies. This will save billions in ongoing costs. While some truly high-cost areas will continue to need both start-up capital and operating support, the emphasis for any new rural broadband infrastructure spending should be on those locations for which capital alone can overcome the need for further government subsidy. This will deliver the most bang for scarce taxpayer bucks.

After determining the optimal per-location subsidy needed, the government may find there are more providers willing to build in underserved rural and tribal areas than there are funds to support them. If so, the FCC should be authorized to run a reverse auction among competing providers to bid down the per-location cost.¹²

The FCC has already proposed such a solution to improve the efficiency of existing universal service programs, with the goal of letting market forces deliver “the best deal available” to maximize limited funds.¹³

3. *Extend “Dig Once.”* Lack of coordination between broadband and other infrastructure projects wastes time and resources, particularly when roads are being built or maintained. It is essential that we fully embrace a “Dig Once” rule, requiring installation of conduits for broadband equipment whenever roads are being dug up for any reason. According to the Government Accountability Office, “Dig Once” can reduce the cost of deploying fiber under highways in urban areas up to 33 percent and up to 16 percent in rural areas.¹⁴

At least two bills circulating in Congress now would expand existing “Dig Once” policies.¹⁵ Dig Once should also be extended to state roads, and to all public rights of way adjoining roads.¹⁶

4. *Address other unproductive barriers to mobile deployments.* On the mobile side, the good news for local authorities is that 5G networks will rely not on macro cell towers so much as small cell sites, with small, low-power antennae that can be attached to existing poles and on buildings.

There will, however, be an explosion of such installations, significantly increasing the pressure on local authorities to review and approve applications. To ensure U.S. dominance in 5G deployment, network operators will need authorities to use predictable criteria, reasonable and consistent terms, and proportionately quick time frames for review.

¹²See Blair Levin and Carol Matthey *In Infrastructure Plan, a Big Opening for Rural Broadband*, Brookings Institution, Feb. 13, 2017, available at, <https://www.brookings.edu/blog/the-avenue/2017/02/13/in-infrastructure-plan-a-big-opening-for-rural-broadband/>.

¹³FCC, *In the Matter of Connect America Fund Universal Service Reform—Mobility Fund*, WC Docket No. 10–90, March 7, 2017, available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-17-11A1.pdf.

¹⁴See Letter from Government Accountability Office, June 27, 2013, available at <http://www.gao.gov/assets/600/591928.pdf>.

¹⁵See, e.g., MOBILE NOW Act, S.19, 115th Congress (2017–2018); Broadband Conduit Deployment Act, H.R. [], 115th Congress (2017–2018). Similar provisions were proposed in the Streamlining and Investing in Broadband Infrastructure Act, S. 2163, 114th Congress (2016–2017).

¹⁶A coalition of public policy think tanks wisely recommended at a recent hearing that the policy be expanded to state roads, and to all public rights of way adjoining roads. Available at http://docs.techfreedom.org/Letter_EC_Hearing_on_Dig_Once.pdf?ct=t%28PR_LabMD_Amicus_January_20171_4_2017%29&mc_cid=87bf010f7a&mc_eid=f62145b79f.

Local authorities should of course retain the ability to ensure public safety of new equipment, but much of the sometimes permanent delay operators already experience in managing applications has little if anything to do with legitimate public policy concerns. As former FCC Commissioner Robert McDowell recently cataloged, investments are increasingly being held up by ad hoc or outdated processes, unrelated turf wars, and petty corruption.¹⁷

At a minimum, Congress should establish Federal guidelines to eliminate unnecessary bickering over pole attachments, especially for poles that are municipally-owned or owned by regulated utilities. To avoid rent-seeking behavior that grinds the process to a halt, we need cost-based attachment fees, “climb-once” policies, and basic rules about notice and contractor qualifications. Network operators should not be penalized in either time or money for replacing or upgrading small cell equipment—applications that are often treated as full-scale installations of new towers.

The FCC has already begun the process of establishing more aggressive shot clocks and “deemed approved” rules, but Congressional action on these common-sense improvements would be easier to sustain over likely legal challenges.¹⁸

5. *Re-engineer government processes that hinder private investment.* Beyond pole and building access issues, both wired and mobile deployment is being held back unnecessarily by unproductive costs associated with dealing with slow and overly bureaucratic local governments. The problem is not so much local regulations as it is local processes—or often, the lack thereof.

As Google Fiber’s unique approach to selecting its markets has shown, commitment to efficient permitting and deployment strategies by local authorities can prove decisive in which cities get new private infrastructure investment and which ones do not.¹⁹ Simply providing a single point of contact within a local government can make a big difference in both speed and cost of deployment, along with access to city property and streamlined zoning processes. If inspectors don’t show up when promised, moreover, an entire project can be stalled at enormous expense.

Both municipal employees and installers would also save a great deal of time by moving from individualized permits to a single project-based permit. The individual permits repeat much of the same information, putting a strain on resource-challenged planning departments to evaluate redundant information, slowing down reviews with no benefit.

Local governments must be cured of the bad habit of holding approvals hostage until broadband providers agree to pay for unrelated public works, such as repairing streets even where no work is being performed. This is an inefficient solution to local funding problems, one that disproportionately impacts costs for broadband consumers.

Especially given the coming explosion of small cell deployments, there is widely-held consensus that outdated and overly bureaucratic local processes are particularly holding up deployment of mobile infrastructure, a problem that is guaranteed to get much worse if positive steps are not taken soon.

A few years ago, I discovered first-hand just how chaotic and ad hoc local approaches can be. A mobile provider applied for permission to install a handful of new low-power antennae on existing utility poles in my small unincorporated Bay Area town—equipment needed to improve 4G LTE service in the hills just north of Berkeley.

Though county officials were ready and able to review and decide on the applications on a professional basis, doing so took over a year, held up by free-for-

¹⁷Robert McDowell, *Clearing the Barriers to Critical Communications Infrastructure*, Mobile Future (April 20, 2017), available at <http://mobilefuture.org/clearing-the-barriers-to-critical-communications-infrastructure/>

¹⁸FCC, *In the Matter of Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment*, WT Docket 17–79 (April 27, 2017), available at [http://transition.fcc.gov/Daily_Releases/Daily_Business/2017/db0330/DOC344160A1.pdf?ct=t\(PR_LabMD_Amicus_January_2017_4_2017\)&mc_cid=10c138d1f0&mc_eid=f62145b79f](http://transition.fcc.gov/Daily_Releases/Daily_Business/2017/db0330/DOC344160A1.pdf?ct=t(PR_LabMD_Amicus_January_2017_4_2017)&mc_cid=10c138d1f0&mc_eid=f62145b79f); FCC, *In the Matter of Accelerating Wireline Broadband Deployment by Removing Barriers to Infrastructure Investment*, WT Docket 17–84 (April 27, 2017), available at [http://transition.fcc.gov/Daily_Releases/Daily_Business/2017/db0330/DOC-344161A1.pdf?ct=t\(PR_LabMD_Amicus_January_2017_4_2017\)&mc_cid=10c138d1f0&mc_eid=f62145b79f](http://transition.fcc.gov/Daily_Releases/Daily_Business/2017/db0330/DOC-344161A1.pdf?ct=t(PR_LabMD_Amicus_January_2017_4_2017)&mc_cid=10c138d1f0&mc_eid=f62145b79f); *City of Arlington v. FCC*, 133 S.Ct. 183 (2013).

¹⁹See Larry Downes, *U.S. Digital Infrastructure Needs More Private Investment*, HARVARD BUSINESS REVIEW, Oct. 14, 2016, available at <https://hbr.org/2016/10/u-s-digital-infrastructure-needs-more-private-investment>.

all hearings of unrelated committees and local advisory groups. These meetings were regularly derailed by the misrepresentations of outsiders who characterized the applications as being for new, full-size cell towers, upsetting and misleading residents for no good reason.²⁰

These are especially frustrating and counterproductive inefficiencies, ones that represent some of the most unnecessary obstacles to accelerated broadband deployment. They must be resolved quickly. 5G networks, once deployed, will be truly competitive with very high speed and highly-reliable wired networks. They will not only provide underserved areas of the country with faster and cheaper broadband options, but will take the mobile computing revolution to the next level for all Americans, and at increasingly attractive prices.

Best practices distilled from a long history of good and bad examples should be established at the Federal level and included in the infrastructure bill as conditions for local jurisdictions to receive Federal assistance.

6. *Make investments technology-neutral.* For the most sparsely populated and geologically challenging parts of the United States, the economics of laying fiber-optic cable are unlikely to make sense any time soon, even with subsidies. So the question becomes not only what alternative broadband technologies are best suited to rural and mountainous regions, but how to encourage providers to continue developing and deploying them.

In many rural areas, for example, fixed wireless technologies have proven themselves capable of providing high-speed last-mile connections to homes and businesses, with the promise of even better performance going forward. Satellite-based solutions have also matured, as have hybrid fiber/copper technologies using existing telephone lines.²¹

But up until now, Universal Service programs have either explicitly or implicitly favored wired technologies, for example by defining minimum broadband speeds above what is reasonably necessary or by setting latency standards in a way that intentionally excludes satellite-based solutions.²²

No matter how the infrastructure bill provides for broadband in the remaining unserved locations, it should do so on a technology-neutral basis to encourage continued development of new options.

7. *Address nonfinancial causes of the digital divide.* Though the focus of this hearing is on obstacles to deployment, I want to say a little about the equally important problem of adoption. Again, there is broad consensus on both the problems and common-sense solutions.

As the most recent data from the Pew Research Project shows, we are winning the battle to reduce broadband cost for those least able to afford it. In addition to expanded Universal Service programs and the shift from voice to broadband for Lifeline and other programs, leading Internet providers, including Comcast, AT&T and, recently, Sprint, have expanded programs aimed at low-income families, signing up millions of new Internet users for roughly \$10 a month.²³

As the adoption gap narrows, however, we need new strategies that target different problems. Availability and price are no longer the most significant factors holding back the 13 percent of Americans who remain offline. Consistent with finding over the last decade, the Pew Research Center noted recently that only 19 percent of offline adults cite the expense of Internet service or owning a computer as a barrier.

Instead, “[a] third of non-internet users (34 percent) did not go online because they had no interest in doing so or did not think the Internet was relevant to their lives.” Researchers reported. “Another 32 percent of non-internet users

²⁰ See Rick Radin, *Kensington Gives Partial Approval to AT&T Antennas*, THE MERCURY NEWS, July 31, 2013, available at <http://www.mercurynews.com/2013/07/31/kensington-gives-partial-approval-to-att-antennas/>.

²¹ Richard Bennett, *Wireless First: A Winning Strategy for Rural Broadband*, High-Tech Forum, April 11, 2017, available at <http://hightechforum.org/wireless-first-a-winning-strategy-for-rural-broadband/>.

²² See Doug Brake, *A Policymaker's Guide to Rural Broadband Infrastructure*, Information Technology and Innovation Foundation (April 2017), available at http://www2.itif.org/2017-rural-broadband-infrastructure.pdf?mc_cid=4fb4705a17&mc_eid=98756dc702.

²³ Larry Downes, *The Digital Revolution Has Not Reached All of Us*, THE WASHINGTON POST, August 31, 2016, available at [tps://www.washingtonpost.com/news/innovations/wp/2016/08/31/the-internet-revolution-has-not-reached-all-of-us/](https://www.washingtonpost.com/news/innovations/wp/2016/08/31/the-internet-revolution-has-not-reached-all-of-us/).

said the Internet was too difficult to use, including 8 percent of this group who said they were ‘too old to learn.’”²⁴

While income undoubtedly continues to play a significant role in non-adoption, in other words, many who remain offline wouldn’t use the Internet even if it were free. This conclusion was also reached by a recent NTIA survey, which found that over half of those who don’t have Internet service at home—again, largely rural and older Americans, and those with less education—say they just don’t want or need it.²⁵

Part of this resistance comes from the fact that unconnected Americans don’t know how to use a computer or even a smartphone, let alone how to install and maintain networking equipment inside or outside their home. So whatever funding the infrastructure law provides for broadband will be wasted if some of that support isn’t directed to providing hands-on education and on-going support. Community groups and senior centers are natural conduits for these essential services.

8. *Use the bully pulpit to encourage digital want-nots.* Given the Internet’s growing importance for education, health care, jobs, and civic engagement, there is also agreement that non-adopters are simply and tragically wrong in thinking broadband isn’t relevant to their lives.

It is, therefore, incumbent on those of us already enjoying the benefits of the digital revolution to employ creative new approaches to convincing them to join us. Solving the training and support issues of the least tech-savvy users will go a long way to overcoming potent inertia, but it won’t fully answer the relevance problem. Digital want-nots also need to understand the value of getting online.

These include the obvious benefits of connecting to family and friends and expanding entertainment options. But there are more fundamental ways emerging technologies, including the Internet of Things and smart homes and communities in particular can improve quality of life, especially for seniors hoping to age in place in their homes.

Many of these benefits were vividly described in the later chapters of the National Broadband Plan, but neither the FCC nor the White House used the Plan effectively to promote a vision of tomorrow that would make getting online today irresistible.²⁶

Public education about why the infrastructure bill is spending money on broadband will be critical to getting maximum value from any new investment. That effort should include, at a minimum, the White House and related Departments including those dealing with commerce, housing, health, energy and education.

The FCC should be tasked with coordinating the public outreach, and for working with start-ups and established companies developing the most exciting and relevant applications and their respective trade groups in public-private partnerships.

Much as organizations such as the Consumer Technology Association put on local trade shows for government officials, the FCC should develop visionary presentations about our broadband future. Then, the Commission should take it on the road, in the form of high-impact mini-trade shows, helping those who don’t believe in the value of connectivity see and hear first-hand what it is they are missing already and what’s ahead in the near-future.

Following these basic recommendations will maximize the value of any taxpayer money spent on broadband infrastructure. Even more, these simple steps will help multiply government spending with continued private investment, accelerating efforts to close the digital divide and bring the least-connected parts of the country into our growing digital conversation.

In Silicon Valley, that’s what we call a win-win-win.

²⁴ Monica Anderson and Andrew Perrin, *13 percent of Americans Don’t Use the Internet—Who are They?*, Pew Research Report, Sept. 7, 2016, available at <http://www.pewresearch.org/fact-tank/2016/09/07/some-americans-dont-use-the-internet-who-are-they/>

²⁵ National Telecommunications and Information Administration, *Digitally Unconnected in the U.S. Who’s Not Online and Why?*, Sept. 28, 2016, available at www.ntia.doc.gov/blog/2016/digitally-unconnected-us-who-s-not-online-and-why.

²⁶ Following the Plan’s publication, the focus for policy leaders in and out of the FCC was on the spectrum crisis the Plan identified—alarms that Congress, the FCC, and network operators have so far responded to admirably.

I am happy to expand on any of these points, and look forward to your questions. Thank you.

The CHAIRMAN. Thank you, Mr. Downes.
Mr. Hendricks.

**STATEMENT OF BRIAN M. HENDRICKS,
HEAD OF TECHNOLOGY POLICY AND PUBLIC AFFAIRS
FOR THE AMERICAS REGION, NOKIA CORPORATION**

Mr. HENDRICKS. Thank you, Chairman Thune, Ranking Member Nelson, and members of the Committee. Thank you for the invitation to share Nokia's thoughts on how to encourage broadband deployment. As the Chairman mentioned, I am an alum of the Committee and had occasion to exchange notes with Senator Hutchison yesterday; she sends her regards to all of you. I also got the impression she thought this might be comic retribution for all the hearings I made her sit through.

[Laughter.]

Mr. HENDRICKS. So please be kind.

We commend the Committee for your work on the MOBILE NOW Act. Nokia is very supportive of that legislation, particularly the spectrum provisions. We think that this and your continued interest in creating spectrum opportunities are important in building a foundation for investment in the technologies that will enable a truly connected society.

The good news, as Professor Downes mentioned, is we have excellent broadband networks in the United States, they are just not deployed everywhere we want them, and they will require massive investments in order to evolve further in support of the use cases that we are contemplating for the connected programmable world. These include things like connected health care, intelligent transportation, and smart cities.

As I note in my written testimony, the technical challenges we face in supporting emerging demands are considerable. We will need peak data rates to get much higher. We will need to drop latency, which is the delay in transmission in networks, to near zero to ensure that applications with no-fault tolerance, like autonomous driving vehicles and remote medical treatment will work reliably. The size and cost of the infrastructure we deploy must be smaller, while at the same time delivering higher functionality, such mobile edge computing and analytics.

Tens of billions of dollars of investment is required in research and development and in the deployment of new infrastructure and software to grow capacity and coverage of our networks. Many different technologies, including Wi-Fi, multiple generations of wireless networks, and satellite must work together to form a comprehensive technology framework.

The good news is there are hundreds of entities large and small willing to make this investment. We need to help assure that their intentions become the reality. We need to think very carefully about regulatory policies and understand their impact on the cost of deployment and the type of returns investors can realized on those deployed assets.

Rational actors don't make uneconomic investment. So key to encouraging investment will be ensuring an opportunity for innova-

tive products, pricing, and new revenue sources. We need to avoid policy shocks that disrupt planned investment, such as making changes to the tax code, such as those proposed in the House. I mentioned this more extensively in my testimony, but the single greatest impediment to broadband infrastructure investment that this Congress could conceive would be to adopt limitations to interest deductibility.

Many providers of broadband services use the debt market to finance their acquisition and deployment of technology, and tens of billions of dollars will ultimately be drained out of that opportunity. We recognize that the tax reform you're looking at is a comprehensive set of tradeoffs. We recommend highly that that not be one of them that you consider.

We need to continue finding ways to improve access to Federal land and assets. Whether you're a fan of shot clocks or would prefer other avenues to streamline the process, such as requiring agencies to permit multisite applications to allow for the reduction of duplicative impact studies and reduce legal costs, it's clear more can be done. We're encouraged by the Committee's work in this area, and we follow the developments quite closely, including many of the ideas that Senator Heller has recently put forward.

In addition, we need the FCC to move forward aggressively with its proceeding on siting challenges and to use its Broadband Deployment Advisory Committee as a place to bring together stakeholders, including industry, states, cities, and towns, to identify the best practices and a plan for replicating them in jurisdictions across the country. It would be beneficial for Congress to clarify and bolster the authority of the FCC, particularly as it relates to the range of structures and locations covered under Section 253 of the Communications Act and the reasonableness of fees and charges. We note there are several ways to do that, any one of which can greatly improve upon our recent experience.

We should continue to refine programs within congressional and Federal purview that can assist with the affordability of certain infrastructure deployments and ultimately end-user connections.

Nokia would like to see broadband as a focus in the upcoming infrastructure bill, and we would encourage you to prioritize funds toward early deployments of IoT verticals like smart city, connected and intelligent infrastructure, and connected health care. We think that doing so will help considerably with the demonstration of the value proposition to broadband consumers and improve adoption rates. Higher uptake is a key way to improve the business case for broadband deployment, particularly in rural areas.

Finally, let me say that Nokia has frequent interaction with stakeholders across the country. As we worked in support of FirstNet's outreach to states and to ascertain the availability of infrastructure for that massive undertaking, we learned a great deal about who is investing in broadband technology, the state of the infrastructure, and how investment decisions are made.

As you consider ways to address the challenges of rural broadband deployment, I would encourage you to make sure you continue hearing from those that face those challenges most directly. They often do not have Washington offices, and they may come here once or twice a year, but co-ops, as one example, provide

broadband coverage to 40 percent of the Nation's land mass with only 5 percent of its population. Understanding the solutions necessitates understanding the problems. We think they can offer some critical insights and should be part of this conversation.

Thank you. I would be happy to answer any of your questions.
[The prepared statement of Mr. Hendricks follows:]

PREPARED STATEMENT OF BRIAN M. HENDRICKS, HEAD OF TECHNOLOGY POLICY AND
PUBLIC AFFAIRS FOR THE AMERICAS REGION, NOKIA CORPORATION

Chairman Thune, Vice Chairman Nelson, and members of the Committee. Thank you for the opportunity to share Nokia's thoughts about ways to encourage and improve broadband deployment in the United States.

Nokia

Nokia is a leading innovator in the technologies that connect people and things. With business activities in more than 125 countries, we are driving the transition to smart, virtual broadband networks and connectivity by creating one single network for all services. We are converging mobile and fixed broadband, IP routing and optical networks, with the software and services to manage all of these technologies. Supporting Nokia's comprehensive connectivity portfolio is a world-class research and development program led by the award winning U.S. based Nokia Bell Labs, and with additional R&D centers in the United States, Europe, and Asia. Nokia invested more than \$5 billion in R&D during 2016, adding to a portfolio that now exceeds 90,000 patents. Our researchers and engineers continue to develop technologies that will transform the way people and things communicate and connect, including: 5G wireless technology, ultra broadband access, IP and Software Defined Networking ("SDN"), Cloud applications, IoT and security solutions, data analytics, and sensor and imaging technology that will be widely utilized in IoT applications.

Nokia is also a major facilitator of the emerging Internet of Things ("IoT") market through our "ng Connect" program. With Nokia's "ng Connect" program, we have built an ecosystem of more than 300 members including leading network, consumer electronics, applications, and content providers. The IoT community of the ng Connect program brings innovative companies together to collaborate on solution concepts, end-to-end prototypes, business models, and market trials that will unleash the full potential of the IoT.

Broadband Deployment in the United States

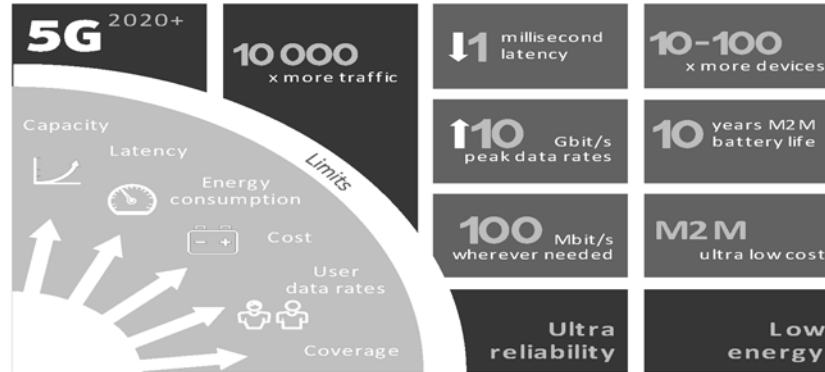
The United States is fortunate to have very good broadband networks, particularly with respect to wireless broadband. However, as noted by many researchers, in spite of considerable Federal and state policy efforts over the last decade, we have not been able to deploy truly high-speed broadband capability ubiquitously throughout the country. There are persistent, known challenges underlying this reality. Therefore, it is timely to take a fresh look at this issue as the Committee is now doing. Nokia commends the Committee for its work on the MOBILE NOW Act. This legislation, once enacted, makes critical changes to siting of infrastructure on Federal land with improved access to rights-of-way, and further directs the FCC and NTIA to work on a range of spectrum that is critical to mobile broadband development. We see this legislation as a critical step forward and urge its prompt passage. Importantly, Congress continues to hear about spectrum policy from industry groups. The reason is that the need for a predictable, flexible supply of spectrum for broadband use, across a range of bands, is a foundational element of the connected society. It is not a subject that can be addressed in one bill and then deprioritized. We encourage you, the FCC, and NTIA to continue your aggressive work on spectrum policy.

We stand at a very important moment with a huge leap forward in technology applications and services emerging at a rapid pace. Once relegated to the confines of science fiction novels, ideas like autonomous driving vehicles are no longer distant aspirations. As we look at the near and mid-term, Nokia believes that there will be substantial advancement in the areas of connected health care, intelligent transportation and infrastructure, and Smart Cities among others. Augmented and virtual reality, machine-to-machine communication, remote diagnostic medicine and perhaps even a tactile Internet, with instantaneous feedback to a user enabling things like remote surgery, being among the possibilities. More of our learning, commerce, health care delivery, and daily living will take place via a broadband connection, making the availability of high quality, affordable broadband a necessity for modern living now more than at any time in our history. We have not fully ad-

addressed the so-called digital divide with current generations of technology, so there is a danger that the divide will not only persist, but could actually widen. If more commerce, learning, and quality of life enhancing activities like health care take place in a digitized context, and people in some areas of the country lack access to a connection, the divide between users in different geographies and socio-economic strata will grow. Fortunately, there are opportunities to engage this challenge.

To place the technical challenges ahead of us in context, consider that Nokia believes that we will see a more than 10,000 fold increase in the amount of traffic on networks over the next 5–10 years resulting from deeper penetration and uptake of mobile broadband, dramatic increases in connected devices and machines, the expansion of the industrial Internet, and connected transportation and health care among other applications. On the mobile broadband side, we believe that in order to accommodate the increase in traffic and the sensitivity of many emerging applications like autonomous driving cars and connected healthcare, network peak data rates will need to increase to more than 10 Gbit/sec (gigabytes per second) with at least 100 Mbit/sec everywhere in the network. For perspective, reaching that type of peak data rate would require a jump potential a hundred or more fold from where we are today in many deployed networks.

The massive increase in capacity, and in coverage, needed to create a network environment capable of the foregoing will require substantial investment in infrastructure, particularly small cells and distributed antenna systems to “densify” network deployments. Densification of networks is a core strategy to elevate capacity and capability of wireless networks in order to reach latency (delay in packet transmission) levels below 1 millisecond, which will be necessary for many future use cases. For context, reported latency rates in U.S. wireless networks during 2016 ranged from a low of 60 milliseconds in LTE networks to a high of 163 milliseconds in older 3G networks.¹ These are fast networks, and they do a great job of providing reliable wireless broadband service to consumers that support the voice, text, and video services for which they were designed. But, it is clear that significant upgrades are needed to reach a reality where zero fault tolerance applications like autonomous vehicles can be widely deployed.



Nokia view of 5G wireless network conditions and requirements

The good news is that wireless carriers, large and small, in the U.S. are prepared to make the necessary investment and meet the challenge. In fact, broadband providers of all kinds including cable companies, utilities, municipalities, and cooperatives (which are an essential part of the rural broadband strategy) all stand ready to invest significantly in broadband infrastructure to support the foregoing vision of a connected society. However, the decisions made by regulators and legislators at the state level, and here in Washington will have a significant impact on their collective ability to deploy and continuously upgrade broadband infrastructure. Based on our experience as a major partner for companies and communities that deploy broadband technology, Nokia believes that there are three key things that policymakers need to be mindful of in fashioning regulatory and legislative actions if the true objective is to create an environment conducive to robust investment:

¹ See e.g., Comparisons of networks drawn from mobile subscribers at <https://opensignal.com/reports/2016/02/usa/state-of-the-mobile-network/>. Industry figures vary, and in many cases suggest even lower latency figures that continue to improve as additional investment is made.

- (1) Regulatory policy impacts the ability of providers to monetize infrastructure investment and can be a major driver of costs and delays in broadband infrastructure deployment;
- (2) The relative health of the investment environment for broadband infrastructure is heavily influenced by regulatory activities as noted, but also by fiscal policy actions Congress may undertake such as an infrastructure bill and comprehensive tax reform; and
- (3) Emerging use cases are both a driver of broadband network requirements and consumer interest in, and adoption of the technology. Adoption rates are a key component of the business case for major infrastructure investment, particularly in rural and underserved areas. Industry and policymakers can do more to shape consumer expectations and uptake of the technology.

Regulatory policy impacts

Over the last several years we have seen a major focus on regulatory policies like privacy and network neutrality here in Washington. These are important issues with a real need for clear standards and rigorous, predictable enforcement to provide consumers critical protections. Unfortunately, they have also become a source of considerable uncertainty for markets. Nokia is not a broadband service provider, so when we look at issues like these it is to discern how rules and restrictions will shape the scope of our ongoing research and product development (such as research demand for additional computing power and analytics capabilities in our infrastructure solutions), and the market for broadband infrastructure more generally. And, there is a clear impact in our experience.

In the case of the FCC's now repealed broadband privacy rules, limitations on broadband service provider access to, and utilization of data that is routinely available to other technology companies in the ecosystem directly limited the capability of broadband providers to realize potential value creation opportunities in the future. And, that alters the value calculation that providers make in determining whether, and how much to invest in certain technologies. In the same way, the *ex ante* prohibition of innovative pricing models (for example fee based prioritization directly at the consumer's direction) under the net neutrality rules, and the inclusion of a nebulous "general conduct standard," in our judgment created a significant risk to broadband provider investment. The prohibition on new pricing options and the general conduct rule make any significant deviations from current practices in traffic management, data plan pricing, or creation of specialized services risky from a legal and regulatory standpoint. Those risks have been a regular discussion point between broadband providers and their suppliers, and have directly impacted product discussions including whether to continue developing specific features in new products and whether to move forward with specific deployment plans. Along with an observable decline in capital expenditures in the last two years, these developments are a clear indication of a negative impact on investment from the regulation.

My purpose in raising these two issues, which I understand to be the subject of very passionate debate, is not to make a normative judgment about what the FCC did, or should do, or even what Congress should do. Rather it is to bring the conversation to a point where there is an understanding that regulatory choices directly impact the decision making of private actors, and ultimately how capital expenditure decisions are made. To put a finer point on this, we note that there is a frequent focus on profit and loss statements of telecommunications providers in these debates: wherein we hear that profits are healthy therefore investment will continue to happen and regulatory factors have not impeded capital deployment. In our experience, profit is frequently not an accurate, or at least not a complete, barometer of the health of the investment environment. Indicators like average revenue per user (ARPU) and return on capital employed (ROCE) are more tightly linked to the investment decisions of broadband providers because they are measures of how well a provider is monetizing prior capital investment and what the returns on planned investment will be. When policy shocks occur, they directly impact the forecasts that providers have relied on in making capital decisions, and those decisions are then altered. Since the adoption of the network neutrality order in 2015, the ARPU of all but one U.S. wireless carrier has declined as opportunities to introduce new sources of revenue were constrained.²

Whatever position one takes on the issues of privacy and net neutrality, and we take none here; restrictions on the ability to generate marginal revenue through certain innovative activities like data analytics and prioritization invariably impact the capital expenditure decision making because they limit the ability to fully and flexi-

² See <https://www.statista.com/statistics/283513/arpu-top-wireless-carriers-us/>

bly monetize marginal infrastructure investment. There is a range of very reasonable opinion about these issues. Our hope is that as Congress considers these issues moving forward, it will do so with careful deliberation on how a legislative solution (which we strongly favor) will balance consumer protections with the impact to the capital decision making of the very providers we want to invest in improving connectivity.

State and local: Regulatory issues at the state and local level will also impact the ability to deploy broadband infrastructure at levels necessary to realize the vision for a connected society. As I noted earlier, the next generation networks will depend on a massive deployment of new infrastructure. The need for this increased wireless infrastructure, and other necessary broadband infrastructure investment, has already reached a critical level. Unfortunately, Nokia has experienced first-hand the frustration of local coverage needs being thwarted by local siting practices. Common problems fall into several related, and overlapping categories, as follows:

- Undefined laws and processes and/or a lack of personnel;
- Redundant, fragmented procedures; and
- Onerous and prohibitive fees

In our experience, many jurisdictions have ill-defined processes for receiving and processing requests to site infrastructure. The lack of defined procedures leads to inefficiencies and haphazard results. We have found that jurisdictions that lack defined procedures are often not familiar with the legal landscape intended to remove barriers to deployment. As an example, although some larger cities are experienced with Section 6409(a) of the Spectrum Act, even those jurisdictions typically have not revised their processes to incorporate that law. Actions that qualify for 6409(a) streamlined treatment, nevertheless can be delayed by localities seeking modified lease terms, for instance, when attempting to negotiate a master agreement or franchise license prior to requesting regulatory siting approvals. Many local governments are using these master agreements as a substitute for a more comprehensive legal framework (effectively creating a *de facto* zoning ordinance via contract).

The lack of clear procedures makes the application process much more difficult from the beginning—it can be hard to know where to even start—let alone ultimately obtaining the required authorization to move forward. It is therefore not surprising that jurisdictions that suffer from ill-defined, haphazard processes also lack the employee resources to process siting requests. We understand that local jurisdictions often face budgetary constraints, however, lack of employee resources exacerbates a number of other impediments. Each unnecessary extra step (or steps) in the process that should result in modest delays can clog the deployment pipeline entirely when coupled with a lack of government personnel. In most cases, the overwhelming majority of the time necessary to deploy a small cell has nothing to do with the process for acquiring the equipment, installing it, or connecting it to power and backhaul: it is time spent obtaining review and approval.

In addition to process and personnel limitations, Nokia often experiences multi-layered review processes involving several agencies within a jurisdiction. This leads to review and approval timelines that are not easily discernable from one authority or interdepartmental agency to the next. In one major city example, the process is fairly well defined, but involves three or four different phases, which occur in seriatim instead of concurrently. While review times should be in the 90-day range, approval often takes double that, layering delay on top of delay. Depending on the number of site applications that are under review with the government, at any given time, the timelines to approval for the initial application can challenge the viability of the entire deployment.

Fees that are assessed for initial access, recurring access, and things like regulatory site inspections can threaten the economics of an entire deployment. Nokia, and our partners, have experienced site “inspection fees” of \$3,000 or even \$4,000 applicable to each location. These per-location fees are particularly outrageous when put in the context of hundreds, or even thousands, of small cells planned for a single deployment. Many localities lack personnel to inspect individual macro-cell (large, frequently tower based) sites; so, the timeframes and expense that would be applied to small cell deployments under the current approval framework is a major concern. Notably, the \$3,000–4,000 fees do not include other application fees and recurring fees associated with accessing the location.

The fee problem is further exacerbated by an emerging cottage industry of third party consultants who see the complexities of citywide deployments as a business opportunity, becoming a middleman. The goal of the consultant is often *not* to maximize connectivity, but rather to maximize city revenues. Consulting agreements also frequently provide broad marketing and management services rights that include

revenue sharing options with the locality based on the lease terms that the third party is able to negotiate with the carrier. Nokia has recent experience with this problem. Consultants frequently enter the mix in preparation for major events that lead to short-lived local economic development initiatives. From a business perspective, a service provider may plan to build for the longer term, with infrastructure intended to benefit a community long after the event is over. Yet consultants often push for higher fees for these temporary high profile projects, and the result is we do not achieve the type of long-term economic development that would better serve residents and businesses.

Once higher fees are charged due to an event-specific deployment, those rates then become precedent, and set a rate floor for future deployments, not just in that particular city, but also in other locations where the consultants are working. In multiple cities where Nokia has participated in preparations for a short-lived event, we have found the elevated fees to be prohibitive and backed away from participation only later to see those elevated fees cited by consultants to localities as a benchmark for other longer term deployment projects.

Nokia certainly understands that thinly staffed localities would turn to such consultants with promises of generating additional revenue for city activities. And, there is some value in the temporary use of third parties to process applications and negotiate rates in reducing delays from personnel shortages, provided that the third parties have experience in the issues involved and are truly temporary to deal with the short-term expected surge in applications for small cell deployments. The risk, however, is that the ultimate beneficiary of this arrangement is the consultant, and the citizenry loses through less robust deployment and higher subscription fees needed to support the expensive rights-of-way fees the consultant extracts. The introduction of a new layer of participant, the contracted consultant, with their own profit motivations skews the charges assessed against network operators and equipment vendors even further from the “cost recovery” level. Taken with the sheer number of small cells and distributed antenna systems (“DAS”) that are planned for 5G network densification efforts, the consultant-driven costs provide an almost insurmountable barrier to deployment in many jurisdictions.

The use of consultants has moved well beyond the events context, and is now proliferating across a widening geography. As noted, these consultants have an incentive to drive up the fees assessed in each subsequent jurisdiction to leverage ever increasing fees for their own financial gain due to the nature of their retention agreement compensation terms. Each locality becomes the new benchmark for the next consulting contract, driving rates ever higher. Nokia believes that the FCC and Congress should view the hiring of such consultants to negotiate siting rates skeptically. This type of retention becomes counter to the objective of facilitating broadband deployment when win bonuses or other fee level based compensation are utilized. Nokia therefore has told the FCC in written comments to find that this type of compensation is not appropriate and may be a basis for applicants in impacted jurisdictions to obtain relief from the Commission. We have attached an example of marketing materials representative of the kind these consultants send out to cities as an exhibit. Revenue sharing and the maximization of revenues are featured prominently, to further our point.

There are several additional challenges Nokia sees in the deployment of infrastructure, many of which have been noted to, and are being examined by, the FCC. These include: (1) total moratoria on deployments in some jurisdictions, (2) severe restrictions on the size of new equipment or the imposition of restrictions or new fees on modifications to existing deployments, and (3) utterly uneconomic per site access fees (initial and recurring charges) in many cases assessed on a per pole or point basis. Just some examples cited to the FCC in its previous proceeding looking at these issues:

Moratoria: An Illinois city has denied all permits to locate small cells along ROWs. Another city in that state is refusing to process permit applications until it can enact a new ordinance on small cells. A Florida county has a moratorium blocking all ROW installations. There could be as many as 17 other city or county moratoria in Florida.

Partial restrictions and arbitrary conditions:

- Texas city is refusing to allow any wireless facilities in ROWs;
- New Jersey city requires a public bidding process to attach facilities to utility poles but has failed to seek bids for more than six months;
- Several California cities require providers to demonstrate gaps in service coverage as a condition of ROW access;

- Florida city limits the number of small cell installations (regardless of the number of providers) to 13 sites in one square mile;
- Several Illinois jurisdictions impose minimum distance requirements of up to 1,000 feet between small cell installations, even when the installations serve different wireless providers;
- Other jurisdictions impose limitations on the height of poles that can house small cell infrastructure.

Fee examples:

- California city is demanding up to \$20,000 in annual ROW fees. Two other California cities charge ROW fees per pole of over \$1,000 per month and \$2,300 per month respectively;
- A Massachusetts city requires a \$5,000 up-front fee before it will negotiate a ROW use agreement. Another city in that state is demanding a \$6,000 per pole annual fee;
- A Minnesota city is demanding a \$6,000 annual per pole fee;
- An Oklahoma city charges more than \$2,500 per year per small cell;
- A company that holds a contract with New York to manage wireless facilities is demanding fees of \$9,000 per year for small cells;
- The New Jersey Department of Transportation is requesting \$37,000 per year per for each new facility located in state highway ROWs; and
- The Virginia Department of Transportation charges \$24,000 per year for each new structure in state highway ROWs.

From Nokia's perspective, it is quite clear that major Federal action is required to alleviate these barriers to deployment. The form of that action is no doubt going to be a contentious give and take with some preferring broad Federal preemption of state and local time, place and manner regulation and others suggesting we need to respect local autonomy. Nokia's view is that neither extreme is a good policy solution. It is quite true that states and localities have an interest in public health and safety and the use of their local regulatory authority to advance those interests. However, it is also quite clear that many practices, including those that I have cited, are conspiring to create an environment that is deeply adverse to the Committee's stated interest of broadband deployment. And, these practices are not isolated; they are spread across many states and localities of all shapes and sizes. So, what can be done about this? Nokia suggests the following:

- Highlight the broad benefits to the public that will come with the densification of infrastructure deployments, things that are not possible today but can be a reality in a connected society. There is an excellent report from Accenture attached to my testimony that further highlights this;
- Allow the FCC's refreshed proceeding on these issues to proceed, and encourage the Commission to look at ways to highlight not just the practices noted above, but also best practices of local authorities. There are some that have been very forward leaning in streamlining regulatory processes. Some states have adopted comprehensive legislation and some localities interested in Smart City deployments have worked to streamline bureaucratic process. These should be examples that we highlight;

Notably, while Nokia supports state level legislation, *we do not believe that this is the optimal solution as a stand-alone strategy*. Network deployments are not planned on a city-by-city, or even state-by-state basis. Uniformity, efficiency, and economic viability of broadband deployment likely require a Federal solution;

- Congress should consider changes to the Communications Act, particularly in Sections 253 and 332 that further clarify and strengthen the FCC's authority to provide a backstop to unreasonable local rules. Whether the result of the FCC's process will be broadly applied shot clocks, fee limitations, and other restrictions, or more of a model template of practices backed by a case-by-case review and approval in the event of unreasonable and non-compliant practices, it is clear that something must be done.

Investment environment

While awareness of how regulatory actions can impact the incentive and opportunity to invest is crucial, these are not the only policy considerations currently before this Congress that could impact the future of broadband deployment in the United States. The House of Representatives will consider comprehensive tax re-

form, likely later this year, and two proposals in particular that are part of those discussions could have lasting negative consequences for broadband investment. First, there is a policy proposal to limit or even eliminate interest deductibility for businesses. Second, there is also a policy proposal to impose border adjustment (so called import) taxes. Each of these would have a major impact on the financial decision making of broadband providers.

The House suggestion to limit interest deductibility is married to another proposal, to change the period of so-called “expensing” or depreciation such that companies could expense 100 percent of the equipment up front rather than depreciating it over a longer period (typically 5–7 years in our industry). It is important to note that while beneficial, the move to the 100 percent expensing model does not change how much money a company may receive in a tax benefit, it simply shifts the money into an upfront time period. Companies will get the same tax benefit as under current law, just faster. By contrast, limiting or eliminating interest deductibility would eliminate billions of dollars worth of current tax benefit (and therefore money available for investment) *permanently*. Put in very simple terms, any entity that relies primarily on debt instruments to finance capital expenditure would see their net cost of borrowing increase due to the loss of interest deductibility. And that means less dollars, billions of them, for broadband infrastructure deployment.

Critically, there are many entities currently involved in providing broadband services, from cable companies and utilities to cooperatives and privately held telecommunications companies that borrow to build. And when they borrow they do not do so for a single deployment, they do so for each capital deployment be it for upgrades or expansion of their network to cover new areas. Therefore, the loss of interest deductibility will impact those companies each time they tap the debt market. For many of these providers, funding investment entirely out of current revenues is not an option, nor is tapping the equity market by offering additional stock for sale. Many are not publicly traded, and among those that are, some cannot realistically dilute the value of their stock by releasing more shares. Debt financing has emerged as a widely employed, rational business approach. Upending that through tax reform will drain tens of billions of dollars out of future investment in broadband networks across utilities, cooperatives, small and mid-sized telcos and many cable providers. While Nokia understands tax reform is a complex undertaking with many tradeoffs, we feel strongly this should *not* be one of them.

There has likewise been significant discussion about the imposition of an import tax as much as 20 percent. As Congress considers tax reform, it is important to recognize how the current supply chain for broadband components and finished products is constructed. While the United States is home to many research facilities (including some of Nokia’s), software development centers, and even component manufacturing, it is also true that many of the thousands of components that make up broadband infrastructure solutions originate outside the U.S. Current ITA agreements and other exemptions have limited the duties assessed against these components, and the result has been lower cost equipment. If Congress imposes a border adjustment tax and/or eliminates the exemptions for electronics and broadband components, the result will be much higher prices for equipment either through duties, or through changes to supply chains to work around those country specific duties that impose higher costs. In turn, the ability of broadband providers to execute their broad deployment plans will be impacted. Again, we understand that tax reform is complicated; we are highlighting the impact to the stated equity of the Committee to improve broadband deployment. While the tax code is not a current barrier to deployment, it could quickly become so if members are not cognizant of the impact of these proposals.

Use cases and adoption

In today’s world, we cannot have a discussion on how to encourage and improve broadband deployment in the United States without taking into consideration the growing Internet of Things (“IoT”) ecosystem and the transformation of the global economy into the Digital Economy. These are fundamental to demonstrating value and generating enthusiasm among consumers that will further encourage adoption of broadband technology. A core consideration of broadband deployment in rural areas is how many potential users will actually adopt and use the technology if network investment is undertaken. It is a key metric in the business case for deployment, and industry must do a better job of both developing the use cases that create interest and value for consumers, and raising awareness of the same.

The growing demand for connectivity and the digitalization of our day-to-day activities will require policy makers to think differently. At Nokia, we are working to build proven IoT use-cases around the world, particularly in the digital health, transportation, public safety, and smart cities areas. For example, Smart City use-

cases require expertise that spans many different fields including finance, planning, transport, energy, safety, telecommunications and more. They also require public-private partnerships (PPPs) that embrace all of these different dimensions. The IoT smart city concept, as other verticals, is a holistic and layered framework that addresses the needs of multiple aspects of smart city projects and allows cities to use urban data to boost economic competitiveness, and build more effective, workable solutions to many city challenges. Along the way, we have seen numerous challenges including some of the regulatory issues I cited previously and others: difficulty in figuring out how to replicate and scale IoT Smart City solutions to different sized cities; layers of stakeholders; lack of technical expertise at the local level; and very challenging procurement environments.

Solutions

1. Encourage Increased Innovation and Investment: policies should seek to encourage innovation and investment through such tools as: collaboration with industry, academia, and other key stakeholders; empowering CIOs and senior city government leadership; R&D investment across vertical sectors; and review of existing laws and regulations before adopting new ones;
2. 5G wireless networks will be a key element in realizing the Internet of Things' promise—Congress can enable test beds in the U.S. Infrastructure—The Federal Government should make additional spectrum available for mobile broadband, implement effective spectrum management programs, and incentivize investment in network infrastructure;
3. Public-Private Partnerships—The Federal Government should incentivize the use of public-private partnerships as a means to accelerate IoT development and adoption, and U.S. global leadership;
4. Funding IoT/connectivity: As Congress considers an infrastructure bill and future funding legislation, we are mindful of the challenges. However, to the extent funding may be available either through redirecting current program activities or creating new ones, Nokia suggests:
 - Funding local government efforts to implement connected technologies and services;
 - Funding large-scale national pilot projects for smart cities that focus on integrating multiple smart city applications with scalable and replicable solutions;
 - Establishing national challenges with prizes to spur the development of IoT applications with high social or economic impact;
 - Funding R&D for key underlying technological challenges relevant to the Internet of Things, such as improving cyber security and reducing power consumption.

We are supportive of many existing Federal programs such as the FCC's CAF program, the rural utility service and others (even those we think need reform). To the extent Congress considers an infrastructure bill, we are supportive of additional funding through grants or tax policy that can lead to additional, targeted broadband infrastructure investment. But, to be clear, in an environment of scarce fiscal resources we believe priority should be given to the priorities we listed.

Thank you again for the opportunity to testify before the Committee.

The CHAIRMAN. Thank you, Mr. Hendricks.
Mr. Weninger.

STATEMENT OF HON. JEFF WENINGER, STATE REPRESENTATIVE, ARIZONA HOUSE OF REPRESENTATIVES

Mr. WENINGER. Chairman Thune, Ranking Member Nelson, and members of the Committee, it is a true honor to be speaking here to be speaking to you today.

As mentioned, my name is Jeff Weninger. I'm a State Representative in Arizona. And I, along with my colleagues, especially Senator Fann and Senator Smith, passed and got signed by the Governor, House Bill 2365 this year, which did a lot of things that are

being talked about, shot clocks, and just created a great environment we think going forward.

Today, you can look down any crowded street in America and, at a glance, see multiple people, young and old, looking at their smartphones or tablets, following online maps, checking Instagram, Snapchat, or Facebook, watching YouTube or Netflix, videochatting on Skype or FaceTime, or accessing one or more countless apps. My mother lives in a retirement community. She used to have a wired Internet connection with a desktop computer. Last year, she got rid of it, and now she sits in her chair for a couple hours a day in the living room and accesses Facebook and e-mail through her smartphone.

Hearing this, it's not hard to understand that mobile data usage is skyrocketing. According to Cisco, in 2016 alone, U.S. mobile data traffic grew 44 percent, and it's expected to grow fivefold from 2016 to 2021. Big events cause people to use their mobile devices even more. At the Phoenix Open golf tournament in February of this year, for just one carrier, mobile data use was equivalent to 26 million selfies. That same carrier had a 60 percent increase with roughly the same amount of people from the very year before at the tournament.

All this is the fun stuff, but mobile devices are critical to more serious matters. According to Pew Research Center, 40 percent of cell phone users said they found themselves in an emergency situation in which having their phone with them helped, and the FCC reports that 70 percent of 911 calls are from wireless phones. My father lives in Tucson, and only has a wireless phone. He does not have a wired phone or a landline. In the last year, he has had to call 911 twice for an emergency. For his sake and the sake of all Americans, it's critical that these devices work when we need them the most.

While these phones, tablets, and apps seem magical, they don't run on magic, they run on hardware and software connected to antennas and ultimately fiber-optic cables, and all of this is installed on towers and poles and in underground conduits. In other words, they require infrastructure. And more and more of that infrastructure will be in the form of small cells which are placed on utility poles, street lights, signs, bus shelters, and traffic signals, and are designed to blend into the existing environment.

FCC Chairman Pai recently said, "The future of wireless will evolve from large macro cell towers to include thousands of densely deployed small cells operating at lower power." These small cells are necessary to meet today's customers' needs, but they're even more important for the next generation of wireless networks, 5G.

We're meeting today's needs and preparing for that future in Arizona, where we just passed a landmark bill that promotes needed investment in small cells while ensuring the appropriate level of local control. Arizonans will know that when they want to use the mobile devices, the infrastructure will be there to support them.

You may have heard that sometimes there are conflicts between wireless carriers, cities, and towns, over how and where these small cells will be built, but in Arizona, we have the support for the bill from the industry players and also from the municipal association, the Arizona League of Cities and Towns.

How did we get there? Simple. We had many productive discussions about how to address the concerns of the cities and towns and others while ensuring the right policy framework for investment. The bill ensures that there is a uniform statewide policy for wireless carriers to get the necessary permits and agreements from Arizona cities and towns, and those cities and towns are able to ensure that small cells meet their local codes for public safety, design standards, and concealment requirements. If the wireless carrier wants to attach to municipal poles, like street lights, the bill ensures that carriers will pay appropriate fees for that attachment.

In summary, I'm very proud that Arizona's new bill is a great example of how the state, cities, towns, and industry can all work together to meet a shared goal of ensuring that the needs and demands of citizens for broadband networks will be met.

And as I'm efficient and believe in shot clocks, I think I finished just in time.

[Laughter.]

[The prepared statement of Mr. Weninger follows:]

PREPARED STATEMENT OF HON. JEFF WENINGER, STATE REPRESENTATIVE,
ARIZONA HOUSE OF REPRESENTATIVES

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Big events cause people to use their mobile devices even more. At the Phoenix Open golf tournament in February, for just one carrier, mobile data use was equivalent to 26 million selfies! That same carrier had a 60 percent increase in data usage at the tournament in 2017 compared to 2016.

All that is the fun stuff, but mobile devices are critical to more serious matters. According to the Pew Research Center, 40 percent of cell phone owners said they found themselves in an emergency situation in which having their phone with them helped, and the FCC reports that 70 percent of 911 calls are from wireless phones. My father lives in Tucson and only has a wireless phone. In the last year he has had to call 911 two times in an emergency. For his sake and the sake of all Americans it is critical that these devices work when we need them most.

While these phones, tablets and apps seem magical, they don't run on magic, they run on hardware and software connected to antennas and ultimately fiber-optic cables, and all of this is installed on towers and poles and in underground conduits. In other words, they require *infrastructure*, and more and more of that infrastructure will be in the form of small cells, which are placed on utility poles, street lights, signs, bus shelters and traffic signals and are designed to blend into the existing environment.

FCC Chairman Pai recently said that "The future of wireless will evolve from large, macro-cell towers to include thousands of densely-deployed small cells, operating at lower power." These small cells are necessary to meet today's customer needs, but they are even more important for the next generation of wireless networks—5G.

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In summary, I am very proud that Arizona's new bill is a great example of how the state, cities, towns, and industry can all work together to meet a shared goal of ensuring that the needs and demands of citizens for broadband networks will be met.

The CHAIRMAN. Nicely done. Thank you, Mr. Weninger.
Mr. Resnick.

**STATEMENT OF HON. GARY RESNICK, MAYOR,
WILTON MANORS, FLORIDA**

Mr. RESNICK. Good morning, Chairman Thune, Ranking Member Nelson, and members of the Committee. I am Gary Resnick, Mayor of the City of Wilton Manors, Florida, and an active member of the National League of Cities and the National Association of Telecommunications Officers and Advisors. And I want to thank both NLC and NATOA for their support with my testimony and their support with these issues over the years.

In addition to my public service, I am an attorney with the law firm of GrayRobinson and head up our broadband practices group, and I want to thank you for the opportunity again to share our perspectives from local government leaders across the country.

I also want to thank the Committee, and in particular Senator Nelson—we Floridians are very lucky to have you representing us, sir—for calling attention to the importance of broadband deployment. As both an elected official and the past Chair of the FCC's Intergovernmental Advisory Committee, I can assure you that no one cares more about competitive broadband choices than local governments. We are not just regulators, but we are large consumers and understand how important reliable, competitive broadband is for our local economies and our residents.

As with other new technologies over the years, the incredible success in rolling out broadband has made it a disruptive technology. It challenges the resolve of all stakeholders, including local governments and industry members, to remain cooperative partners. If we, as a nation, will succeed in providing all businesses and residents from Miami, Florida, to Miami, Texas, with excellent, affordable, reliable service, local governments and service providers must remain cooperative partners, and Federal support for that partnership is essential to deploying successfully the infrastructure needed for broadband.

For years, cities and towns like mine have worked proactively with both service providers and infrastructure companies to support broadband technology. As city leaders, though, we must also balance other important needs of our communities. Our current policy framework supports us in that role, and that's why broadband service and infrastructure has been able to expand so rapidly.

In my community of Wilton Manors, we have supported both service providers and infrastructure companies, including allowing

the use of public property, and we, along with many other local governments, are updating our codes to support access for small cell technology in our public rights-of-way. We have even attempted, in conjunction with transportation construction projects, to deploy broadband infrastructure for use by the industry. However, currently, Federal and state policies prohibit us from doing so.

When local governments do restrict broadband infrastructure, trust me, there are very good reasons, particularly when dealing with requests to install facilities in the public rights-of-way. We are stewards of the public rights-of-way. Our codes exist to ensure that the rights-of-way remain safe for all who are impacted by their use, including our first responders, utilities, the traveling public, and adjacent property owners. We cannot sacrifice these other important interests for one particular use.

There are some concerns with managing the public rights-of-way that are more important to us in Florida than perhaps in other areas. We pay a price in Florida to live in paradise, with severe hurricanes, storms, flooding, and lightning strikes. Any public works director will tell you that with these environmental challenges, it makes absolute sense to construct utilities underground. Not only does this improve aesthetics and increase property values, it provides much reliable utility service and allows first responders and residents to use streets during and after these emergencies rather than waiting sometimes days or weeks until downed power lines are cleared.

Taxpayers in many communities throughout the state have approved referenda to spend hundreds of millions of dollars to underground existing overhead utilities, including recently the town of Palm Beach. The same reason for not favoring overhead utilities applies to broadband infrastructure that may be located in the rights-of-way.

In addition, in Florida, it is vital for our Department of Transportation and cities and counties to maintain what's known as "clear zones" adjacent to roads. Our roadways often border waterways, and the only safe way to pull off a road to avoid an accident and not get submerged, is to have no fixed facilities along such roads. Clear lanes—clear zones—excuse me—are essential for public safety, not only in Florida, but I understand in communities that suffer from heavy snows and ice as well.

My reasons for discussing these concerns is to show that our local codes address very practical issues. There is no one-size-fits-all solution. Local regulation is the only system that works. Unfortunately, there are proposals on the table now that would preempt and minimize cities' roles and reduce our ability to ensure the safe, responsible deployment of infrastructure. Federal policies that preempt local authority to support certain technologies or competitors risk producing winners and losers. These industries are very competitive. If it suddenly became cheaper, faster, easier for a company to deploy its technology, it would create unfair competitive advantages.

Finally, if Congress preempts local authority over public rights-of-way, local taxpayers would be forced to subsidize the broadband industry. Much of the dialogue occurring in the states and at the

FCC would allow wireless providers to attach their equipment to government-owned light poles for as little as \$15 per year. These are very expensive. My city just spent over \$210,000 to install new light poles, and it would not be fair for our taxpayers to pay for this public property to be used virtually for free. As a Mayor, if I give business such perks, my constituents would expect a great deal in return.

We have several policy recommendations for the Committee that are more dealt with in detail in my written statement. First, the Federal Government should prioritize local decisionmaking on infrastructure. Second, Congress should tackle Federal barriers to infrastructure deployment. The MOBILE NOW Act goes a long way to doing that. Third, Congress should allow local governments to use every tool in its toolbox. And, finally, we should consider appropriate education for broadband users. Our first responders are constantly reminding residents that they cannot text to 911 or post an emergency on social media instead of calling 911.

In conclusion, on behalf of the NLC and NATOA and the City of Wilton Manors, I wish to thank the Committee for inviting me to participate in this hearing today. America's local governments are committed to supporting Congress and increasing broadband deployment. And I look forward to any questions you may have.

Thank you.

[The prepared statement of Mr. Resnick follows:]

PREPARED STATEMENT OF HON. GARY RESNICK, MAYOR, WILTON MANORS, FLORIDA

Good morning, Chairman Thune, Ranking Member Nelson and members of the Committee. I am Gary Resnick, Mayor of Wilton Manors, Florida, having served on the Commission for over 18 years and Mayor since 2008. I am also a long-term member of the National League of Cities (NLC) and the National Association of Telecommunications Officers and Advisors (NATOA). The National League of Cities is the Nation's oldest and largest organization representing local elected officials in America's cities and towns. NLC represents 19,000 cities and towns of all sizes across the country. The National Association of Telecommunications Officers and Advisors is the premier professional association that provides support on the many local, state, and Federal communications laws, judicial decisions, and technology issues impacting the interests of local governments. The cities and towns in your states are very likely members of NLC and NATOA.

I currently serve as Vice Chair of NLC's Information Technology and Communications Committee. In addition, I have served on the Federal Communications Commission's (FCC) Intergovernmental Advisory Committee for eight years including as Chair from 2014 through 2016. The IAC provides guidance to the FCC on a broad range of issues important to state, local and tribal governments including cable franchising, public rights-of-way, facilities siting, universal service, broadband access and adoption, and public safety communications. More locally, I have served on the Board of Directors of the Florida League of Cities for 14 years and have chaired various committees for the Florida League addressing communications policies and issues. My background as an attorney with the Florida firm of GrayRobinson, representing businesses and local governments for over 20 years in connection with such communication issues, and my role as Mayor, has afforded me a unique opportunity to work effectively with public and private entities, and local citizens, focused on improving communications services.

I want to thank the Committee for calling attention to the importance of broadband deployment in our communities by holding this hearing and appreciate the opportunity to provide the unique perspective of local governments and our role in promoting broadband deployment. I want to particularly thank Senator Nelson not only for his focus on this issue, but for his excellent service for all Floridians—we are truly fortunate to have him represent us.

No one wants broadband deployment and competitive broadband choices more than local governments. We understand the opportunities that broadband presents for our local communities and our residents in terms of public safety, economic de-

velopment, healthcare, entertainment and education. We are not only regulators of broadband infrastructure and services, we are also large consumers of broadband services, and sometimes even providers. In Florida, for example, the City of Gainesville has been a provider of high speed broadband service for commercial entities for many years. For years, communities of all sizes around the Nation have taken innovative steps to increase the deployment of broadband infrastructure, both wired and wireless, while balancing our health, safety, and welfare concerns.

Local Successes in Broadband Infrastructure Deployment

Local governments like mine have been active partners for years now in ensuring that their residents and local businesses have access to competitive broadband choices. Siting broadband infrastructure in Florida has and is working very well. Both wired and wireless services have been deployed efficiently and effectively in communities throughout our state. While there are some areas where certain broadband wireline providers have not extended their fiber, local governments including my City have worked with service providers to encourage such build out of entire communities, usually with success.

With respect to wireless broadband infrastructure, local governments generally process applications for wireless facilities in an efficient and expeditious manner not only for the benefit of their residents, visitors, and businesses, but also for their own benefit, as wireless services are important for local governments' own communications needs. We appreciate the many benefits of expanded access to broadband options. In fact, many local governments are now actively working to deploy conduit, fiber, towers, and other communications facilities themselves, particularly in conjunction with construction projects in the rights-of-way and on public property, or are planning these for future projects. The goal of these projects is to encourage providers to offer advanced wired and wireless broadband services throughout our communities.

Cities realize that the smart deployment of infrastructure must carefully balance the needs of our industry partners with the public health, safety and welfare concerns of communities. Wireline broadband infrastructure has been built out, with wireline broadband service available throughout Florida, and indeed throughout most of the country, largely because of local governments managing their franchising authority in a responsible manner.

Similarly, the reason why wireless services and infrastructure for macro tower sites have expanded so rapidly in Florida is because local governments have enjoyed broad home rule authority to adopt appropriate land use regulations to make siting decisions that work best for their communities and applicants. Most local codes afford government staff sufficient ability to work with communications providers and infrastructure companies in a way that serves the industries' needs while addressing local land use, public safety and other concerns within their authority. This is particularly important with respect to installing communications infrastructure in the rights-of-way, since Florida local governments are precluded under current State law from entering into agreements for the installation of facilities in the rights-of-way. The relatively recent requests to install small cell and micro cell technology infrastructure in the public rights-of-way has created new challenges as well as opportunities for local governments.

First, we should understand what we are talking about in terms of this infrastructure. I have met on numerous occasions with both providers of wireless service and infrastructure companies that do not provide service but install and manage equipment to lease to providers. We should understand that the term "small cell" does not refer to the size of the facility, but according to industry engineers, refers to the distance that the signal will reach and can be used to provide service only to small areas. The industry has described this infrastructure as "the size of a pizza box," but the type and size of such infrastructure varies greatly with some companies looking to place towers that are 120' tall in the rights-of-way, while other providers seek to site relatively small antenna sites of 6 cubic feet or less that could be collocated on existing light or utility poles. The small cell infrastructure to be located in the rights-of-way also includes equipment cabinets that may be as large as 28 cubic feet or bigger than most refrigerators in our homes. Thus, the infrastructure to be located in the rights-of-way may not be anything like a pizza box but may be more like a pizza delivery vehicle located adjacent to a 120' tower, much bigger than anything else in the rights-of-way. In addition, because small cell facilities reach only small areas, the industry will look to locate a lot of such facilities particularly in densely populated areas, with each provider needing its own facilities since antennas and equipment cabinet are not shared by providers. Thus, some cities may be facing as many as 10 or more sites on one block to accommodate all carriers' small cell networks. Many local governments that have comprehensive policies in place to

address macro towers and infrastructure on private and public property have not been faced previously with requests to locate this volume and size of infrastructure in the rights-of-way and thus, have to consider appropriate policies.

Some cities around the country, such as the City of San Antonio, have worked in consultation with providers to develop master agreements for the placement of such infrastructure in the rights-of-way. The City entered a master license agreement with Verizon which served as a model for other providers, to allow access to city rights-of-way and to attach equipment to certain city-owned structures for an agreed-upon fee schedule. The City found that this proactive agreement allowed Verizon and others to increase coverage and capacity, benefiting both the providers and customers, while allowing the City to protect important safety and land-use concerns, including the City's unique historical aesthetic character.

In Florida as well, there are many examples of local governments working proactively with the broadband communications and infrastructure industries to support deploying infrastructure. The City of Tampa has worked diligently to support expanding communications capabilities for its residents and businesses. The City allows wireless infrastructure on commercial buildings, and the City has leased numerous public properties for the installation of infrastructure for both wireless carriers and wireless infrastructure companies. The City also hosts over 190 free Wi-Fi hotspots and thousands of subscriber-based Wi-Fi hotspots, creating a dense, reliable network for residents and businesses. The City has committed extensive capital and resources to handling rights-of-way registration and permit applications in a timely fashion, ensuring that infrastructure is developed with minimal disruption to city streets or business operations.

The robust deployment of broadband infrastructure has occurred under existing state and Federal communications laws that recognize the important role of local governments and preserve local land use authority while balancing the needs of the industry so that communications services are not effectively prohibited. I have met with many members of the infrastructure industry who candidly have stated that the reason they are seeking access to public rights-of-way as opposed to private property is that access will be quicker, especially if various state bills pass that mandate that local governments grant permits within a short time frame, and cheaper since private property landlords will require rent. From a technical standpoint, the industry has stated that there is no reason that they cannot locate small cell technology on public or private property outside of the public-rights-of-way. The communications laws were never intended to ensure that either the infrastructure or wireless carrier industry has the cheapest and quickest route available to deploy infrastructure. I would caution that such policies in new communications laws would harm competition and discourage innovation.

Important Considerations in Local Regulation

Local governments have a duty to their taxpayers to protect and manage public property and public rights-of-way for the benefit of all users. The public rights-of-way typically are not owned by local governments, but rather are held in public trust for all users of the rights-of-way, including government employees and first responders, public utilities, businesses and the travelling public. In addition to transportation, utility, public safety and land use concerns, we have other valid concerns with managing the rights-of-way, including ADA, environmental, economic development, property value, aesthetics, encouragement of collocation versus new installations, and costs for management and maintenance. Local regulation is vital to ensure that the important interests of both residents and competitive industry users of public resources are protected. This regulation actually protects the long-term viability of the industries in question. For example, if a tower company installs a tower in the rights-of-way without sufficient regard to building codes or safety of the traveling public and persons are injured or killed, no cost cutting or regulatory preemption will save that company. Appropriate local regulations that protect important interests are necessary to maintain viable provider and infrastructure industries.

Local regulations of wireless infrastructure in Florida did not come about in a vacuum. Rather, most localities have adopted land use codes that are consistent with Florida and Federal statutes and regulations after considering input from the affected industries and other stakeholders. For the most part, local governments in Florida have approved infrastructure siting applications as long as there did not exist a land use reason to deny such application. Many local governments, including my City, are actively updating their codes to reflect the relatively new small and micro cell technologies that are seeking to be sited in public rights-of-way.

Local governments in Florida also have unique concerns in managing the deployment of such infrastructure in their communities. More hurricanes, tropical storms, cyclones and lightning strikes occur in Florida than any other state in the Nation.

In the past ten years, 38 of these storms have made landfall in Florida, causing deaths and billions of dollars of property damage. In response, communities around the state have worked hard to make their communities more resilient, by requiring that new utilities be constructed underground, and asking taxpayers to pay to underground existing overhead utilities. The residents of the Town of Palm Beach recently approved a referendum for the Town to spend tens of millions of dollars to underground utilities throughout the Town. Florida communities know very well that constructing utilities underground offers many advantages: utility service is more reliable, particularly in storms and lightning strikes, maintenance of utilities and rights-of-ways is less costly, there is greater safety for the travelling public, community aesthetics are improved and property values increase. Further, when there are catastrophic storms, first responders and residents gain much faster access to streets, without having to wait often several days to address downed utility lines. These reasons that support utilities being constructed underground apply equally to communications infrastructure in the rights-of-way.

In addition, many Florida roads border waterways and canals. Ensuring that the rights-of-way adjacent to roads remain clear is a priority of our State's Department of Transportation as well as counties and municipalities. This is essential for drivers to pull safely off the road or to avoid accidents without submerging their vehicles. State Departments of Transportation and local governments often have such "clear zones" for public safety, requiring that no fixed objects be placed in the rights-of-way or that such areas are not constantly under construction to locate and to maintain facilities. I understand from talking to my colleagues in other states, including South Dakota, that there are similar protections in place in states that are subject to freezing ice and heavy snow storms for the safety of the travelling public. Constant construction and permanent facilities in the public rights-of-way would be just as hazardous in such communities.

Avoiding One-Size-Fits-All Federal Preemption

A one-size-fits-all Federal preemption scheme, either as a result of FCC regulations or new Federal legislation, cannot adequately take into account the diverse and particular needs of communities from state to state. In Florida, under current law, local governments are not able to negotiate and to enter into agreements with communications providers for access to the rights of way. My city for example, could not enter into the type of agreement that San Antonio entered with Verizon. Our only authority to address our valid concerns with use of our rights-of-way while accommodating the needs of communications providers is through our codes. Federal preemption of local governments' codes could leave Florida counties and cities without a way to address our vital interests that Federal courts have determined are lawful areas for us to regulate under Federal and Florida law. Because of Florida's unique law with respect to local control over rights-of-way for communications facilities, the FCC and Congress must be very cautious about interfering with local authority. There could be unintended consequences that would be harmful to the communications and infrastructure industries as a result of inappropriate Federal action.

The Federal Government should also be careful not to pick winners and losers through law or regulation. Both the service provider and infrastructure industries have become extremely competitive, not just in Florida but around the country. Making it easier, faster, or less costly for a particular technology, competitor, or type of infrastructure to be deployed will create significant competitive advantages and harm viable competitors. If Congress or the FCC encourages particular technologies, it will remove incentives to develop better technology. For example, prioritizing the deployment of "small cell" wireless infrastructure, which covers only a small area of service may have negative consequences. Affording these technologies advantages under Federal law could limit the deployment of technologies that would provide greater coverage and be less physically impactful on our environments.

Local regulations may actually incentivize advances in technology. For example, local government regulations that require collocation if feasible before a new tower can be constructed, have encouraged the industry to adopt better methods to collocate more facilities on existing towers and structures and have led to safer tower practices and more efficient use of infrastructure resources. Local needs for hidden or stealth infrastructure have led to the development of new kinds of smart street furniture and advances in infrastructure camouflaging.

The Federal Government must also not ask taxpayers to subsidize these industries to boost one type of infrastructure over others. Preemption of local fees or rent for use of government-owned light and traffic poles, or fees for use of the rights-of-way amounts to a taxpayer subsidy of wireless providers and wireless infrastruc-

ture companies. There is no corresponding benefit for such taxpayers such as requiring the broadband industry to reduce consumer rates or offer advanced services to all communities within a certain time frame. While it could be said that the benefit is that the wireless provider industry will deploy 5G for consumers, there is certainly no requirement being discussed. Further, it is hard to find a public benefit by giving special concessions to an infrastructure industry that does not provide service to consumers, but earns revenue by constructing, managing and leasing infrastructure. Light and traffic poles paid for by taxpayers are not cheap. My City has had the occasion as part of roadway improvement projects to purchase many new lights poles over the past several years. In 2016, we purchased 22 new poles for Dixie Highway at a cost of \$5,340 per light pole. Total cost of installation with directional bore, conductors, conduit, distribution system, etc. was \$209,350. In 2012, we purchased 34 new light poles for a project on Powerline Road at a cost of \$4,357.70 per pole and total cost of installation of \$249,277.30, and in 2010, a similar project for installing 51 new light poles on Wilton Drive cost \$344,756.90. Many of the industry advocates argue that the industry should be allowed to use such light poles for free or for as little as \$15 per attachment per year. Why should our taxpayers pay for the infrastructure to be used by these for-profit companies? The onus is on Congress to negotiate on behalf of the American public, and if it offers handouts to industry, it must negotiate something tangible in turn that improves service for consumers—not just promises or predictions of increased competition in the future. As a Mayor, if I were negotiating to provide perks for certain businesses, I would certainly be expected by my constituents to get a good deal for them in turn.

In addition, during my years serving on the IAC, we devoted substantial attention to broadband adoption and why roughly 20 percent of the Nation's households do not subscribe to broadband. Certainly access to broadband figures into this, particularly in rural and tribal areas where carriers have refused to construct infrastructure because of relatively low returns on the capital investment. However, what the IAC and the FCC have realized is that for many residents, broadband is simply not affordable. Local governments, including my City, have worked hard to make broadband available to such residents, often through Federal programs such as CDBG, by setting up community centers, schools and libraries and free Wi-Fi in parks and government buildings where residents can obtain free access to broadband as well as education on how to use and not to use broadband. In any discussion about supporting infrastructure, we should not lose sight of the ultimate goal of having affordable broadband available for all residents.

Policy Recommendations for the Committee

To ensure that all Americans have reliable access to affordable, truly high-speed wireless broadband, local governments through NLC and NATOA have proposed a number of actions the Federal Government can take to increase competition and the reach of broadband.

- *Prioritize Local Decision-making on Infrastructure*—In addition to avoiding further Federal preemption of local police powers, Congress and the FCC should encourage further local input in Federal decision-making processes. The FCC's recently-formed Broadband Deployment Advisory Committee, or "BDAC," is tasked with advising the FCC as to state laws and local ordinances to address small cell infrastructure deployment. However, I and my local government colleagues around the country have concerns since only one member out of 29 on the Committee is a local government official. With all due respect, the other members of the committee have never voted on a local government ordinance. More local government representatives should be appointed to this body.
- *Tackle Federal Barriers to Infrastructure Deployment*—This Committee has already taken numerous steps to speed wireless broadband deployment through the bipartisan MOBILE NOW Act. By freeing up Federal spectrum, streamlining access to Federal lands, building a database of available infrastructure, and implementing common-sense dig-once policies for Federal construction, the Committee is helping to eliminate obvious barriers to deployment in Federal systems. Congress could go further, particularly as it considers comprehensive infrastructure legislation, to ensure that Federal transportation dollars and other Federal funding programs are not restricted in a way that prohibits the inclusion of conduit or dark fiber in state and local government projects. For example, my City recently completed a multimillion dollar improvement on Dixie Highway largely with Federal transportation funds. When we wanted to install conduit underground as part of that project, we were told the funds were restricted and we could not do so, even if we wanted to pay the extra labor and

material costs for the conduit installation. We have a larger project commencing next year and would like to install conduit. Federal infrastructure funding programs should recognize that broadband infrastructure is a necessary part of bridge, tunnel, and roadway projects. The IAC completed a Wireless Report at the request of the FCC last December, which is maintained on the FCC's website. One of the things we realized, surprisingly, is that the FCC does not maintain remotely complete data as to macro towers that may be available for collocation. The IAC recommended that it would be a good practice for local governments and the FCC to maintain such information to collocate wireless communications facilities more easily.

- *Allow Local Governments to Use Every Tool in the Toolbox*—We need every tool in the toolbox to ensure our residents can have access to affordable, modern broadband and do not wind up subsidizing the provider and infrastructure industries without obtaining significant benefits in return. That means allowing local governments to implement innovative policies like dig-once, which reduces the cost of underground broadband infrastructure, or touch-once, which minimizes the time and disruption necessary to add new broadband providers to existing utility poles. In addition, we should have the ability to negotiate with the broadband industries. Verizon approached the City of Fort Walton Beach, FL to obtain access to government property including government infrastructure in the public rights-of-way. The City entered into an agreement with Verizon that afforded the access it needed and also provided substantial benefits for the City and its residents including market rates of over \$2,000 per attachment. My City as well has negotiated for the use of public property in exchange for benefits that accrue to my City's residents. Virtually all local governments have entered into similar arrangements. Allowing local governments and industry members to work together to reach win wins is by far the best state and Federal policy. Cities also need the freedom to develop municipal broadband networks, if appropriate, without outright or effective preemption that limits competition. Smaller and rural communities that have successfully developed partially or wholly publicly owned networks have found this option to be a critical lifeline in a market that does not allow private providers to realize a sufficient return on investment to serve these communities. As broadband has become a necessary component for cities to retain talent and attract business, denying them this option ensures that they will continue to experience "brain drain" and fewer economic opportunities.
- *Education*—Finally, while we all support the goal of making broadband available for everyone, as policymakers we should be considering appropriate education on how to use and not to use broadband. We all know that broadband should not be used for certain purposes, such as identity theft, bullying, and other inappropriate but available uses. Also, not all broadband content is appropriate for all users. Many cities are educating residents on broadband. For example, my City and others often remind residents that posting something on social media is not a substitute for calling 911 in an emergency. First responders do not monitor social media. In the IAC, we often discussed the social responsibility that should accompany the technology, but those issues were not really within the FCC's scope. Perhaps they are within Congress's.

Conclusion

On behalf of the City of Wilton Manors and my colleagues with NLC and NATOA, I want to thank the Committee for inviting me to participate in this hearing today. I offer the ongoing assistance of local governments as you examine ways to increase broadband deployment responsibly across our Nation. I urge you to view local governments as strong partners in ensuring that broadband services are available to all Americans.

Thank you again. I look forward to any questions you might have.

STATEMENT OF HON. SHELLEY MOORE CAPITO, U.S. SENATOR FROM WEST VIRGINIA

Senator CAPITO [presiding]. Thank you. I just made a meteoric leap to the Chair's chair.

[Laughter.]

Senator CAPITO. It's so nice to be here. Well, thank you. And I want to thank Chairman Thune. Obviously we were just called for

a vote. He has gone to vote, and he has yielded me the time to make my statement and ask some questions. I'm not going to reiterate all the benefits of broadband. I'm from West Virginia, a state that has challenges that many of our states have.

I appreciate Ms. Cooper's testimony when she references the GAO Report that says states' access to affordable broadband telecommunications is vital to economic growth and improved quality of life for the country. So we need to have it easily accessible and to try to help those areas who have been unserved.

So today I want to announce I am going to be introducing a bill called the Gigabit Opportunity Act, which builds on Chairman Pai's idea and vision of "gigabit opportunity zones." It seeks to expedite the deployment of broadband in low-income rural areas. And in the GO Act, the FCC would be directed to release a framework to streamline broadband laws in states, counties, and cities. There are a myriad of different hoops that have to be jumped through, but once adopted, I think Governors would be able to nominate portions of their states' low-income areas as "gigabit opportunity zones." So I hope my colleagues on both sides will join with me to get the flexibility and the streamlining of existing regulations.

Mr. Downes, in your testimony, you mentioned the unintended consequences of unfocused investments, and you mentioned the stimulus package in 2009. Certainly, in West Virginia we had a major investment, and we're still 49th in deployment. Encouraging broadband has been difficult—you know, not having the competition that we need, the burdensome regulations obviously are holding us back.

What suggestions besides what you have in your written statement would you put forward for future investments if and when we get to an infrastructure package that includes broadband? You mentioned \$20 billion, and you mentioned that FCC should be in charge rather than having the three different pockets. Would there be anything else you would add to that statement?

Mr. DOWNES. Yes. And thank you. And I had an opportunity, Senator, to look at your draft legislation, and it was very encouraging, so I hope it does move forward.

Senator CAPITO. Thank you.

Mr. DOWNES. So obviously we know that some of the broadband stimulus money was spent better than others. And I think one of the things we learned even from all three different bureaus is that we have to watch these projects more closely and more professionally, frankly, and make sure that when we make a loan or we make an investment to a private party to do an infrastructure bill, we can't just leave it alone, we have to watch them. Because a lot of these projects got into trouble, some of the contractors were not very experienced, and they just were allowed to go on and spend money and deliver nothing. So I think much more professional management, and as I say, so far the FCC did the best job, but they could use a lot of help as well.

Senator CAPITO. One of the areas I've struggled with is the way that broadband deployment is reported and measured. For instance, if you have the census tracts, you can have an entire tract, and if you serve one person or one household in the census tract, then that census tract is considered "served" in some reporting. Do

you have a concern as well as to the actual data that we're receiving as to who is getting this service and who isn't?

Mr. DOWNES. Yes, I do. I agree that the measurement by census tract is obviously not the best. And it goes the other way, too. You start to see things that look like they're unserved based on, sort of, the criteria that the FCC and others use to determine what constitutes broadband, how much latency is allowed, and so on. That, frankly, has excluded satellite up till now. So I think we can do a much better job of pinpointing just where the real problems are. But, as you know, we already have a pretty good idea of the unserved communities and the underserved communities and where they are, and that should be the focus.

Senator CAPITO. Do you find, though, a bit of a disconnect into what your definition of underserved might be; for instance, the CAF-II money is going to providers to go to underserved and unserved areas? And I've been pushing, at least in my state, to make sure that we go to unserved because it doesn't really do as much good, I don't think, to up somebody's speed before somebody even has availability of the service. Do you have a comment on that?

Mr. DOWNES. Yes, no, I completely agree. The unserved communities ought to be the focus certainly of any actual Federal spending. In fact, that should be the exclusive focus. And we should use this reverse auction process once we figured out what the real investment requirement would be to get over the high cost to find the least cost provider and do it in a way that maximizes the public spend.

Senator CAPITO. Thank you.

And, Mr. Weninger, I would like to say our state and our Governor just signed a broadband bill under kind of controversial circumstances, so I want to take an opportunity to thank him, Governor Justice, for signing it and the legislatures that put it into effect. And I'll be interested to see how it compares with what you all have done in Arizona. So thank you for being here today to bring that forward. Thank you.

Mr. WENINGER. Thank you.

Senator NELSON. Ms. Cooper, this is exciting. You're going to put up 4,000-plus satellites, you're going to cover every part of the globe. Tell me how you're going to get along with those that put the pipes down that run into the houses. Are you directly competing against them or are you going to cooperate with them and concentrate in the areas that they can't serve with 5G?

Ms. COOPER. Thank you, Senator. The constellation we're planning to build will cover the globe pretty equally. So the service will be available globally where we can manage our landing rights and develop our capacity on space.

The business we plan to develop is meant to go direct to consumers, those consumers who seek to subscribe we would seek to serve. We are still several years away from deploying that service. I would expect that there would be significant uptake in areas that have no service now, but we also expect in areas where there are relatively few consumers with choice that we would be a new competitor entering the market. That I think is a question that will unfold in the years as we become closer to service rollout.

Senator NELSON. OK. More competition.

Mr. Mayor, you have testified that you don't want the Feds to mess around with the state and local regulations related to the expansion of broadband. So explain more in detail, what do you think about the FCC rulemaking that they are considering? And if they adopt what they're considering, what impact is that going to have on the agreement states and cities have already made on wireless siting?

Mr. RESNICK. Thank you, Senator Nelson. The success in rolling out broadband over the years has been made possible by the current framework of local regulation. Macro towers have been deployed effectively throughout the entire country. Virtually everybody around the country has access to wireline broadband, also made possible through local regulation.

The FCC's proposed NPRMs to potentially preempt local authority would have, I think, devastating effects on the industry and on the choices available for consumers. What local regulations show is that a one size does not fit all, it's not possible, and it also tends to pick winners and losers.

If we create incentives or give special treatment for small cell, which by the way is not small. There has been a lot of talk about small cell. That term refers to the size of the coverage, it doesn't refer to the size of the facilities. Some of our communities have been approached by companies wanting to put 120-foot poles in the rights-of-way accompanied by refrigerator-size equipment cabinets. They are not small. They just provide service over a very small area. So that's the term, "small cell," it means the size, the distance of the service that it can reach, not the size of the facility. They are definitely not the size of pizza boxes.

But companies like SpaceX that want to innovate with new technology should be encouraged, and if we adopt policies that preempt local authorities solely to encourage more small cell facilities being built in our rights-of-way, what's it going to do for innovation? It's going to discourage innovation, it's going to favor one competitor over the others, and it's going to basically create winners and losers. So that type of policy that would preempt local regulation would not be a very good model to follow.

The local regulations, however, have encouraged innovation. For example, local governments can require collocation as opposed to building new towers. That does encourage innovation because the industry has to become more creative about how to obtain the signal as opposed to just building new towers everywhere. Also, there is innovation now where there is technology that can use actually manhole covers to provide the same type of coverage that small cell technology provides. Local governments can require stealth and camouflage requirements with respect to this technology. If the FCC preempts those types of local initiatives, it's going to discourage innovation, it's going to hurt certain competitors that are entering the business, and we don't think it's appropriate.

Senator NELSON. OK. Madam Chairman, I'm going to go vote, and I will ask them to hold the vote for you until you can get there.

Senator CAPITO. Thank you. Thank you very much.

The Chair is back, so I will—

The CHAIRMAN. Feel free to keep going.

[Laughter.]

Senator CAPITO. I need to go vote.

The CHAIRMAN [presiding]. Thank you. Thank you for your patience and your indulgence. And Members of Parliament from the north, thank you for being here. You get to witness what is our experience when we have votes going on in the middle of hearings.

[Laughter.]

The CHAIRMAN. So thank you for being here.

Let me pick up. I know that there have been a few questions asked already by my colleagues, but as I made clear in the situation in Custer, South Dakota, that I mentioned in my opening remarks, unnecessary bureaucratic delay in securing permits wastes time and deprives consumers of critical services.

So, Mr. Downes, in our efforts to streamline deployment, we don't want to step on local interests or discourage experimentation, but we do want to identify where logjams exist, like along the lines of what we're experiencing in Custer in South Dakota, that serve no public interest. And so the question is, can you comment on your findings with regard to some of the practices that you've found wasteful?

Mr. DOWNES. Sure. So, thank you, Senator, for the question. I don't think that this is an all-or-nothing or it's not black-and-white. I think there are lots of things at the local level that are specific to the locality and also we've seen I think an example of the build-out of Google Fiber and now other gigabit fiber services. We see what happens when localities are incentivized to experiment. Their competitive spirit gets up and they start to discover a lot of things about their practices that don't make sense or just don't fit in that environment, and they get rid of them. And certainly as we move into 5G, we're going to see a lot of communities saying, states and localities saying, "We want 5G. We want to be leaders in this innovation. It's an opportunity for economic growth. And we're going to experiment in ways that we can to get it in as quickly as possible."

At the same time, there is a lot that's wasteful. I live in an unincorporated community in Contra Costa County in California. The county people are very efficient, they're very professional, they have their rules and regulations, but as soon as there is even a hint of a new antenna going up on an existing utility pole, we've got all sorts of, sort of, ad hoc local authorities and people who get involved in the process, and that's usually where the delay is coming from. They don't know what they're debating about. They think they're talking about a full tower install when they're not, and that's just part of what drags things out. As I say, it's not the regulations, it's the lack of uniform process, even just having the inspector show up when he's supposed to. If they don't, then we can have very expensive delays for no good reason.

So I think there is that kind of waste that's easy to get out, and I think that's really what the FCC is getting at in the latest NPRM, not to foreclose local interests.

The CHAIRMAN. Let me direct this one, if I might, to Mr. Weninger. And by the way, congratulations on the Bill 2365 that you had passed in Arizona. Your bill was aimed at streamlining infrastructure policies at all levels of government to pave the way for the deployment of next-generation wireless services to the people in

your state. It's particularly noteworthy, I think, that your bill earned the support of the League of Arizona Cities and Towns. And so I'm wondering what lessons we can learn, as Federal policy-makers, from how state and local authorities in Arizona worked together to speed the deployment of next-generation services. Maybe you can talk about your legislation, how you worked out and reached out to and created a sort of integrated approach among all the levels of government in your state.

Mr. WENINGER. Thank you, Mr. Chairman. Yes, the inner workings of that was about 20 stakeholder meetings that were very intense in the beginning and did get heated. But once we figured out what each side really wanted, what the industry wanted, and what the local governments wanted, it got easier.

The local governments were concerned about some of the things brought up here: concealment, aesthetics, public safety. So we addressed those and gave a lot on that.

The industry is very concerned with price and speed, so the shot clocks. We instituted and settled on a 75-day shot clock, and essentially about \$200 total when you added up the \$50, the \$50, and then a \$100 fee.

But I think it's important within that framework, that with the shot clock, if you look at some of the things that were happening before, we had Verizon took 3 years to get nine master lease agreements in place with nine different cities. And when you have these companies coming in and putting forward millions and millions of dollars in infrastructure, and you have hundreds of cities and towns that have all different rules, all different fee structures, you're never going to be able to keep up with technology, you're always going to be behind, and you're always going to have people who are lacking.

We all came together, but one reason we did all this is because there were some people who were dragging this process out. One city has put up 71 of these, and in every case, they said they had to have an inspector, they were charging thousands of dollars, they were essentially charging the same amount, inspections and everything that you do for the large cell towers, and in all 71 cases of those poles, they made the company replace them anyway. So the company had to buy them a brand new pole and had to wait for 6 months to a year to ever even get it up.

But in the end, and I will submit it to you that the Arizona League of Cities and Towns was great to work with, but this was not a conservative organization. But we worked hard with them and we figured out what both sides wanted and needed, and in the end, they weren't just neutral, they supported the bill, which, again, got out of the legislature unanimously out of both houses, and the Governor signed.

The CHAIRMAN. Mr. Hendricks, again welcome back to the Committee. I notice you have something at your feet, and I'm told it may be a small cell. So maybe you could tell us a little bit about that piece of equipment and show us what you brought with you today.

Mr. HENDRICKS. Certainly, Mr. Chairman. And I think it's particularly important, given Mayor Resnick's comments moments ago about small cells not being small.

This is a fairly typical Nokia small cell. [Witness displays case demonstrating size.] They come larger. They also come as small as a drink coaster. They come with capabilities to transmit from a few meters up to a few kilometers on the basis of the particular technology and software that is on board.

One thing that is, I think, very important to understand, as our friend from Arizona was just outlining, about how regulatory costs impact deployment. Not even taking some of the more outrageous examples that we have seen, a \$3,000 site inspection fee to put this on a pole, \$2,500 a month—or \$2,500 initial charge for the attachment, \$1,500 a month in return charges, makes this a \$22,000 enterprise just in regulatory costs to get it put on a pole. That doesn't include labor, that doesn't include getting power to it or backhaul to it, or the costs of going through the regulatory process.

So if we were to deploy, again, fairly modest, 200 of these in a city, that's \$4.5 million in cost just to get it on a pole and keep it there for a year. We think that we need to do considerably better than that. We've also seen—and I outline this in my testimony—some great partners. Nokia has great partners with communities. We serve 30 or so municipal broadband systems. We're a major partner in the FirstNet project that will be building the wireless network.

So we have great experience and great partners, but we also have encountered extraordinary problems jurisdiction to jurisdiction, some places that have no process at all, so that you don't know where to begin, some places where five agencies will be involved in seriatim looking at the application, the costs and fees that are associated here. The advent of third parties who have been coming in to negotiate on behalf of cities for these agreements have sprouted up kind of like crabgrass in the spring, and they have revenue-sharing arrangements with the city that are designed to extract as much as possible for the cost of placing these facilities. All of those things take the cost of the deployment well beyond, in many cases, what makes the project viable. And the timelines are also an issue. So—

The CHAIRMAN. Thank you. We appreciate that.
Senator Fischer.

**STATEMENT OF HON. DEB FISCHER,
U.S. SENATOR FROM NEBRASKA**

Senator FISCHER. Thank you, Mr. Chairman.

Representative Weninger, you talked about some of the changes that Arizona has recently made with your bill regarding wireless broadband deployment. The Nebraska legislature is working on legislation to ensure the infrastructure necessary for these new technologies is available.

In the broader context, what do you see is the role of states in working with Federal, local, and also private entities to reduce the barriers to broadband deployment?

Mr. WENINGER. Thank you, Senator. One thing I thought was interesting as I was coming here was looking over one of your bills, which was kind of mapping out Federal and government facilities, and I thought that was interesting because in a lot of these more rural communities and different parts, there is a lot of times gov-

ernment infrastructure and government buildings and government workers. Sometimes in our communities, they're the largest employer in some of those rural communities. So I thought that was important.

But, yes, I think the states always—hopefully we can work with you like we worked in Arizona with the cities to help get this done. It's just—I keep coming back to this, and I like using real world examples—it's just so important for everybody, rural, and low-income neighborhoods, and everywhere else. I mean, when I go back to my hotel tonight, using data, I'm going to FaceTime with my daughter and be able to talk to my daughter pretty much in real time like I'm there.

I mean, technology is advancing so quickly, and I'm one who embraces it and thinks it's amazing, and anything we can do for you, as a state, or to work with the Federal Government or Nebraska, I think, is a good thing.

Senator FISCHER. Thank you. And Mr. Downes and Mr. Hendricks, as we look at new technologies, for example, the Internet of Things, that's going to require obviously smaller facilities, and those have differences with the current, as you just showed us some of the smaller cell capabilities that we have available now.

When we're looking at these new technologies, how different are the siting policies going to be from the large towers? And how are we going to educate stakeholders to be able to deal with this both at the state and the local level about the importance that we have these rational siting ordinances? How are we going to move ahead on this?

Mr. HENDRICKS. The first thing I would say, Senator, and thank you for the question, is earlier we heard about the major deployment successes we've had on broadband in the past, particularly with wireless. Interesting, when I was here on the Committee and we worked on a major piece of legislation, we passed comprehensive reform to macro cell tower siting, that streamlined things, and the evidence from the field is considerable, that that was a major component in very fast deployment of 4G LTE technology.

So the lesson learned there is when you have rational policies that help to eliminate huge differences place to place, you can get ubiquitous deployment quickly. We think that's true here also, but we also think that when you're talking about adapting your local ordinances to accommodate densification of a network with small cells, that may be hundreds and hundreds of deployments in a city, you can't look at it from the perspective of requiring an individual application for every small cell site. You need to allow things like multisite application so that you can take care of it at once, and you can reduce impact study consequences and costs, and you can have one site selection fee assessed instead of \$3,000 per small cell.

So we do have to change the way we think about these deployments because there is a major difference between a \$400,000 macro tower, with everything including a diesel generator that is deployed there and the small cell that I just showed you.

Senator FISCHER. And the small box, right.

Mr. Downes, did you have anything to add?

Mr. DOWNES. Yes, I would just add that one of the things that's going to be also important about 5G deployment is this is going to

be a technology that's going to evolve and change very rapidly, and so it's also going to be important not to penalize providers when they upgrade equipment or change equipment. If that's treated as a brand-new install, that will slow things down inordinately and obviously discourage better, faster, cheaper service.

Senator FISCHER. So you would think at the Federal level, we also need to be aware that changing technologies will require us to have a different view of the regulations that are in place?

Mr. DOWNES. Yes, I think so. Again, what I would suggest is just learning from the local, the best practices, put that into legislation, that is, the minimum standard, obviously leaving locals to play with opportunities or other kinds of experimentation beyond that, but just have a baseline of sort of minimum requirement for flexibility. That's really going to help everybody.

Senator FISCHER. OK. Thank you.

Mr. DOWNES. Thank you.

Senator FISCHER. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Fischer.

Senator Schatz.

**STATEMENT OF HON. BRIAN SCHATZ,
U.S. SENATOR FROM HAWAII**

Senator SCHATZ. Thank you, Mr. Chairman. Thank you for scheduling this hearing on broadband infrastructure deployment. Improving people's access to the Internet is critical to economic and social development, but it also matters what kind of Internet people have access to.

So just very briefly, Chairman Pai is making a mistake with repealing the Open Internet Order, which will undermine the Internet, as we know it. The Internet is not broken, and there is no constituency to repeal the Open Internet Order.

My first question is for Ms. Cooper. I found your testimony fascinating. Satellite Internet is often associated with low speeds, high latency, high prices. You have asserted that SpaceX essentially changes the paradigm. How?

Ms. COOPER. Thank you, Senator. We have a couple ideas. First, we want to bring the satellites closer to Earth. By bringing them closer to Earth, the latency required in the system to get the satellite back to the Earth is reduced considerably. Our system, we think, will have latencies below 35 milliseconds, whereas traditional satellite services are in the hundreds of milliseconds. That's important for some kinds of applications, but not for everything.

The next problem is being able to offer speeds and sort of capacity that are comparable to what you would see with fiber services today. For that, we propose to build many satellites that have multiple satellites in view, and they're highly intelligent satellites. They can focus their beams at very small areas, allow them to reuse the frequencies that they have very efficiently. That allows us to serve more customers with higher speeds and adapt our capacity where the demand rises and falls.

We are also, I think, uniquely situated because we've got this heritage of applying real innovation to manufacturing, both to the spacecraft, we'll be developing satellites that have not been seen

before, and deploying them using the reusable launch capability that can help us not only deploy quickly but also more cheaply.

So our goal is to provide fiber-like services at market-prevailing prices with a different construct of a satellite architecture.

Senator SCHATZ. You noted in your testimony that in the last broadband infrastructure program satellite received less than 2 percent of stimulus money. What led to that? And how do you think we need to change in whatever we do next?

Ms. COOPER. I would answer that in two ways. The first is, I think satellite architectures need a little bit of conceptualization to make them parallel to their terrestrial counterparts. A satellite terminal looks a lot like a cable modem in sort of its function. It's on the consumer premise. If there's a program that encourages or offsets the cost at the consumer's home for the equipment they need to get Internet, there is no reason why you couldn't include a satellite equivalent. A gateway is equivalent to a router or a switch or a POP, it's part of the network equipment.

I think in the past, being able to apply those to the spacecraft themselves was a conceptual construct that we just never got to. So that was part of the hard work to do, is just to say this is a different kind of architecture. It needs to be sort of aligned with what terrestrial is.

The second is that the satellite services need to be equivalent to the kinds of services that anyone would get in other kinds of areas that are served with other technologies, and that's incumbent on us to provide.

Senator SCHATZ. Does the statutory framework allow for the FCC to do this, or does this require legislation?

Ms. COOPER. I think it will be determined by what program it is that we're talking about. We would like to work with you on it.

Senator SCHATZ. OK. Mr. Hendricks, of the regulatory challenges that you've discussed today, what would you recommend that the Committee work on?

Mr. HENDRICKS. Well, I think in the long run, as both Chairman Thune and Ranking Member Nelson mentioned, the net neutrality issue is one that is a big challenge. I get in the current climate how difficult the conversations are, but we've been running on this regulatory hamster wheel for about 10 years now, and we've gone through several iterations of stop, start, stop, start.

As a technologist, which is what Nokia does, those kinds of regulatory shocks change dramatically the product development that we are doing where you assume you can do things like analytics and look at application-specific prioritization, and then, poof, you can't.

And so Congress settling once and for all what it believes the FCC's authority is and how that authority should be operationalized is a very preferable solution, I think, for most administering. I'm maybe a little more optimistic that we can get there because I think there's a lot more we agree on than not. I think that's an area.

I think we'll have to take a wait-and-see approach to what happens after—if the FCC carries forward with net neutrality NPRM that was put forward. You will then again have, by virtue of the reclassification of broadband services, a common privacy framework that applies to all services. It's a reasonable conversation at

that point to have about whether or not you think what the FTC framework does is the right framework for everyone, but then at least you're back on a technology-neutral standing. So Congress may have an opportunity to look at that as well.

And I think I identified mostly what I thought were things you shouldn't do or that you have to be very cautious in doing, particularly as you consider things like tax reform because I think those challenges are going to be difficult to overcome.

Senator SCHATZ. Thank you.

The CHAIRMAN. Thank you, Senator Schatz.

Senator Cortez Masto.

**STATEMENT OF HON. CATHERINE CORTEZ MASTO,
U.S. SENATOR FROM NEVADA**

Senator CORTEZ MASTO. Thank you. Thank you, Mr. Chair and Ranking Member. So I'm from Nevada, and we have challenges like everyone else with respect to access to rural broadband. So I'm very excited to hear and have this discussion today. And so thank you for all being here.

Mr. Hendricks, you made a number of references in your testimony to smart cities, and this is an area that I'm very interested in working on, and I'm glad you raised it. I'm curious, did you partner with a community under the DOT challenge last year?

Mr. HENDRICKS. I would have to check. I don't recall doing that. One thing I will say is I think Nevada has been probably the most forward-leaning customer that we have dealt with in our discussions. It is very clear, from the Governor to the legislature to the Members of Congress, that there is an interest in making Nevada an attractive place for tech investment, and we've had a lot of fabulous conversations with cities about doing smart city deployment kind of work.

Senator CORTEZ MASTO. And this is why I bring it up, and I'm grateful that, Mayor, you're here as well as a representative. I've worked in state and local government, and I think there is an opportunity at the Federal level to help incentivize local, state, private sector to come together down a path. And I think in Nevada our future is in technology and in promoting technology, and you see that happening, and that's why I bring up the smart cities. This is an issue that I'm interested in looking at Federal dollars to help incentivize communities to really go down this path, both rural and our urban areas. And I'm curious if that's something that you would be interested in seeing in the future as well.

Mr. HENDRICKS. Yes, I think very much. In my testimony, I described that. I think to the extent that there will be funds available for fiscal activities in an infrastructure bill and in other contexts, Nokia very much would like to see priority given to those verticals, including smart cities.

And I think there's an opportunity there. One of our biggest challenges isn't dealing with unreasonable cities, it's dealing with cities that may not have a process at all. And so you can condition participation and receipt of some of those dollars on adoption of a comprehensive zoning ordinance for these kinds of things to facilitate it. So there are some incentives that can be built in that I don't

think have to be punitive in their nature. But we very much support funding for those kind of verticals.

Senator CORTEZ MASTO. And so because I only have a short amount of time, and I would love to hear also from you, Mayor, as well as Representative Weninger. And let me add this to the discussion, because of my background in working in local and state, there are often times when what you do—and you talked about zoning issues, infrastructure issues, you know your community better than everyone, and not every community is the same.

Mr. HENDRICKS. Right.

Senator CORTEZ MASTO. And when we're looking at going down the path with Federal legislation and what we need in this space, I want to make sure that we, at the Federal level, are coordinating and listening with our local governments, our state governments, and the private sector in each community. But I find, as I jump into this area, there are too many organizations that are out there, and nobody is talking or communicating.

I know that we have a Broadband Deployment Advisory Committee created by the FCC Chair as well as the Broadband Opportunity Council and a number of other committees, who are all focused on addressing and solving these issues we are currently facing, and these various committees each have the same intent, but have vastly different makeup, and they're not always talking and sharing the same data.

Would it be simpler if we just designated a lead Federal agency that really focused on addressing and bringing in those local governments and state governments and the private sector to address these issues? Or I would be curious about your thoughts on how we make sure we have that level of vertical communication and that we're all sharing information to the benefit of our communities and the technology that we want to promote.

Mr. WENINGER. I can go real quick.

Senator, you make some great points. And I, too, come from—I was a city councilman, and now where I'm at, at the state legislature, so I kind of see all sides of it including I own restaurants, so I've gone through zoning and different things. I think one of the top problems is that there is this old paradigm of you have this break between the electeds and then you have the people who are in the zoning department, who definitely—I mean, they fought us the hardest, but the electeds wanted it.

I guess it's different then from what the Mayor is saying, because they don't want to have every council meeting and have somebody down there, you know, the place fills up because they're putting up a large macro cell tower, and so they like this kind of being off their plate. But I think you make a great point on the smart cities part because also too often cities always think that everything in the Planning Department has to be paid for by fees. And I've never believed that because you zone a Walmart or whatever, and you have sales tax coming in that's generating money for the city to pay those salaries.

And the amount of money and just on the Internet of Things that can be generated just for private business, but then not only that, for the cities, through smart cities, through efficiencies, they're going to save money where they don't have to go check every water

meter or the trash can kind of things that are coming is enormous, I mean, and that's just going to get bigger.

So, yes, if there can be some organizations speaking with one voice, or the Senate and the Congress speaking with one voice, and interact with the cities, I think it's just kind of an education process of breaking these old paradigms and how business has been done for so long.

Mr. RESNICK. Senator, first of all, I do appreciate your comments, and you're right on. Actually, my father lived in Nevada for 20 years, and I spent a lot of time there, and I've seen some of the communities that have excellent broadband service, and other communities in Nevada, and in Florida as well, that don't have the competitive choices that we all deserve.

There are a lot of barriers now that have nothing to do with local regulations, but unfortunately these are programs that have been in place for many, many years, particularly by the Federal Government, that do prohibit innovation and deployment of technology.

For example, there are communities, including mine, that are undergoing major roadway construction projects using Federal dollars. When my city undertook a several million dollar roadway construction project on Dixie Highway, which is a major road through my city, we wanted to install conduit, very simple. We just thought it would be used by the industry for broadband purposes, and if we can install it as part of this construction project, pay the labor and extra material costs, which were minimal, then this would be a win-win. But the Federal funds that were funding that construction project prohibited us from doing that.

And that exists with respect to a lot of Federal programs as well as a lot of state programs. A lot of times we're doing these construction projects with state dollars, and you can't use those funds to support dark fiber and conduit, which is silly really. And so those are some of the things that we should look at eliminating.

With respect to the committees and which organizations should take the lead on coordinating all of these efforts, it just seems that right now I think some organizations have a goal in mind and then set up a committee to reach that goal without really wanting to go through an honest process unfortunately.

We're very concerned, for example, the FCC's Broadband Deployment Advisory Committee, which I think my colleague here is on, but I think that committee's goal is to adopt or suggest local ordinances for cities and counties to adopt to support the deployment of broadband technology. The problem is there is only 1 out of 29 members on that committee who's a local official, so the local officials are going to be very skeptical about anything that that committee comes out with.

And another committee of the FCC, the Intergovernmental Advisory Committee, which I chaired until 2016, the Governor of Connecticut is the Chair of that committee, and she requested that the FCC appoint somebody from the IAC to serve on this Broadband Deployment Advisory Committee, but that did not happen.

So I know the National League of Cities is working now with industry members, with stakeholders from counties, from states, and they've created a task force to try and come up with basically an education package for local officials around the country, and I'm

sure that they would be willing to work with any stakeholders in this area to support broadband deployment in a more effective way.

You look at municipal broadband as well. There are communities that the only way they will get broadband service is if the municipality makes the investment. In Florida, as well as in states throughout the country, that is prohibited. So you have some policies in place, either on a state and on a Federal level, that prohibit the type of investment that local governments want to make to make sure that their residents do have access to competitive broadband choices, but are prohibited from doing so by existing policies.

Senator CORTEZ MASTO. Great. Thank you very much.

And thank you for allowing me to go over.

The CHAIRMAN. Thank you, Senator Masto.

Senator Cruz.

**STATEMENT OF HON. TED CRUZ,
U.S. SENATOR FROM TEXAS**

Senator CRUZ. Thank you, Mr. Chairman. Thank you to each of the witnesses for being here and joining us at this hearing today.

Mr. Downes, there was some discussion earlier today about the FCC and the regulation of the Internet. As you know, the Internet arose in a very light-touch regulatory environment, and, indeed, much of the reason why we've seen such incredible free speech and free enterprise and opportunity is because innovation did not require prior approval from Federal Government regulations, but, rather, the Internet has been a haven for freedom.

That changed 2 years ago when the FCC for the first time asserted its authority to regulate the Internet as a Title II public utility, treating the Internet under an authority that was designed in a very different context some 80 years ago and not designed with the Internet in mind.

In my view, that decision was lawless, it was a power-grab from the FCC, and it was profoundly dangerous for a Federal regulatory agency to assert the authority to regulate pricing in terms of service on the Internet. One of the great virtues of the Internet has been innovation without prior government regulation. Chairman Pai has wisely stated his intention to reverse that lawless power-grab.

Could you tell this Committee, Mr. Downes, in your judgment, what are the benefits to ensuring that the Internet remains in a light-touch regulatory environment without Federal regulators demanding preapproval before innovation?

Mr. DOWNES. Sure. Thank you for that question, Senator Cruz. So in my filings on the 2015 Order, I shared your view that, net neutrality aside, the principles aside, the real issue was public utility reclassification, and that was my chief concern with the 2015 Order. I don't think we have to look any further than some of our counterparts, particularly in Europe, where permissionless innovation has not been the starting point.

And in my research on disruptive innovation, what we find is that because the speed of change, particularly with digital technology, but you know lots of other technologies, genomic technologies and materials technologies, the pace of change is so rapid,

in a good way, that even the best intended regulatory oversight can unintentionally get in the way.

And my view was that the reclassification of public utility was a very dangerous move in that regard in that it could have led to, as you say, rate regulation and other kinds of things that were there, now forbore from, but could have been unforbore from in some future administration. So I shared that concern and I continue to share that concern.

Senator CRUZ. And I will commend you for introducing the word “unforbore” to this Committee. That may be a first, but indeed it is a danger well to be worried about.

Let me shift to a different topic. Mayor Resnick, earlier this year our committee held a hearing on examining ways to improve our Nation’s infrastructure, and at that hearing, I asked witnesses if deploying small cell networks employing 5G wireless technology could serve as an important component to improving infrastructure.

The Mayor of Miami Beach, Philip Levine, responded by saying, “Whether it’s telecommunications or bridges or tunnels and roads, Congress could appropriate a trillion dollars, but nothing will ever get done because the process is absolutely broken at the permitting level. I don’t care if it’s telecom or a new road, the process is broken. It’s not even about the money. It’s about the process. It needs to be streamlined. We’re in a race with the rest of the world. We’re all wearing handcuffs and weights. It’s priority number one, and I see it as a Mayor.”

Do you agree with Mayor Levine? Is the process at the permitting level a major barrier to effective infrastructure deployment?

Mr. RESNICK. Well, thank you, Senator. And actually Mayor Levine and I are good friends, and his city is—

Senator CRUZ. I figured that was the case.

Mr. RESNICK.—a friend of mine, and they’re dealing with tremendous issues in Miami Beach, including sea level rise and flooding and having a good chunk of their property basically underwater as opposed to waterfront in a couple years, as is my city. So we’re all dealing with a lot of challenges.

I don’t think permitting is broken. I think with respect to this new technology, as I stated in my remarks, it’s a disruptive force. We haven’t had experience dealing with it before. We need to educate our staffs and local officials throughout the country on how to properly deal with the technology.

We are in the process now in Florida, and actually Miami Beach was one of the first in Florida to do this, we are updating our local codes to address the new technology, particularly for access to our rights-of-way because that hasn’t occurred before. But there is nothing in place now that would prohibit the deployment of new small cell technology in our rights-of-way, and we are moving forward to support that technology, we just need some more education and, frankly, a little bit of time to update our codes.

The bill that, for example, passed in Arizona will go a long way in doing that, but we are also very concerned with preemption because there are other communities that have achieved this through agreements. For example, San Antonio, Arizona, is considered a model around the country for having an excellent agreement with

Verizon that then has been used by that city and others as models with other providers around the country.

If the Federal or state government preempts local jurisdiction with respect to these issues, they will prohibit us from entering into those types of win-win agreements with the providers. So we have to be cautious about basically preempting local authority and discretion as well because then you'll preempt these types of win-win scenarios that can be achieved.

Mr. WENINGER. Mr. Chairman, could I possibly address that real quick?

Senator CRUZ. In a brief moment, yes.

Mr. WENINGER. OK. Yes. I just respectfully disagree. Our legislation puts a 75-day shot clock, puts normal fees, and I went through earlier some just really crazy year-long processes. We had nine master agreements done by Verizon that took 3 years to get done. Technology is passing you by, by that point. And I just think this infrastructure is critical.

We did it unanimously in Arizona. There's a way of getting it done where you still protect those local rights, but allow them to deploy this technology in a very efficient, fast manner. We also did batching to where if they do have a problem, they come in batches of 25 that they're putting in, if they do have a problem with two or three of those, they can take those out and the process goes a little longer, and then the others are moving efficiently through the process at that time.

Senator CRUZ. Very good. Thank you.

**STATEMENT OF HON. CORY GARDNER,
U.S. SENATOR FROM COLORADO**

Senator GARDNER [presiding]. Thank you.
Senator Markey.

**STATEMENT OF HON. EDWARD MARKEY,
U.S. SENATOR FROM MASSACHUSETTS**

Senator MARKEY. Thank you, Mr. Chairman, very much. I think we all agree that investment in broadband infrastructure has broad bipartisan support, and there's a simple reason. Obviously it's the engine of innovation in our society, a job-creating machine, it's chaotic, it's entrepreneurial, it goes right to the enterprise identity of our country, but we always have to try to strike a balance.

And so in 2015, the broadband companies, the wireless companies, invested \$87 billion in new infrastructure upgrades. That's great, and that's what we want, but at the same time, one half of all venture capital in the United States went to software and Internet-specific startups, that is, companies which rely upon net neutrality to guarantee that they can reach all 320 million people in America for the business model that they are trying to create. So that's a nice balance: \$87 billion in infrastructure upgrades, half of all venture capital goes into software and Internet-specific startups. Perfect balance.

So my question is, Do each of you believe in a free and open Internet? Yes or no?

Ms. Cooper?

Ms. COOPER. We are not yet a service provider. And we expect that we're going to be subject to the rules of the Commission when we do provide service in a few years, and we expect that the rules are going to have many twists and turns as Congress, the Commission, and the courts continue to look at this.

Senator MARKEY. So yes or no? Yes, you do? You believe in a free and open Internet?

Ms. COOPER. We're not yet an Internet service provider, sir.

Senator MARKEY. Oh, I see. OK. Well, let me just say that I have a document here from 800 innovators, startups, businesses from all 50 states, 800 of them, who have sent a letter calling for the retaining of the net neutrality rules so that they will be able to continue to be job creators in this environment. And that's the tension here, because in the absence of a guarantee, you can't raise the money from the venture capitalists in order to reach their customers if you are going to be dependent upon the broadband carriers to be able to provide the services.

So to the extent to which we all agree that there should be more broadband, there should be, and \$87 billion of investment says we're heading in that direction. To the extent to which new companies want to get in, we shouldn't have laws to prohibit them from getting in at the city and town level. They should be able to get in. They should be able to provide the services. Broadband companies don't like that either. They want to shut down that kind of competition, there's no question about it.

What they also want to do, broadband companies, is they want to, kind of, monetize the privacy of Americans. And we just had a successful effort by the Republicans to pass a congressional review act repeal of the privacy laws that had been built by the FCC into law in order to protect consumers so that you could not sell their information if permission was not received from a consumer.

Do each of you believe that there should be a protection of privacy, that a broadband provider actually is required to provide so that you have to receive permission before you can sell that information?

Mr. Resnick.

Mr. RESNICK. Well, Senator, actually when I was Chair of the FCC's Intergovernmental Advisory Committee, we took up these issues, and we supported unanimously the net neutrality order as well as the privacy rules that were put in place.

Senator MARKEY. Thank you, sir. I appreciate it. Yes.

Mr. Weninger.

Mr. WENINGER. Senator, respectfully, this really isn't my wheelhouse.

Senator MARKEY. OK. That's fine.

Mr. Hendricks?

Mr. HENDRICKS. Although not a service provider, we do absolutely support consumer privacy protections, just not the ones the FCC had adopted.

Senator MARKEY. Mr. Downes.

Mr. DOWNES. Yes, I agree. The framework that the FTC has used for years, which is opt-in, has worked extremely well—I'm sorry, for opt-out, which has worked extremely well. What the FCC wanted to do was opt-in, and I don't think that was a good idea.

Senator MARKEY. Yes. Ms. Cooper.

Ms. COOPER. As we design our constellation, we are committed to building a system that can protect the privacy and security of our customers.

Senator MARKEY. Yes. Well, obviously the problem with opt-out is that, by definition, they've got all your information and they're using it unless you opt-out, whereas with opt-in, they've actually got to come to you and say, "May I have your permission to use all of the financial data that our company has gathered about you, health care data about your daughter searching for information about anorexia at age 13, that you have to get their permission, the family permission, before you start selling that information to 50 companies that might want to start advertising right there on that site toward that 13-year-old girl. So there's a big difference between opt-in and opt-out.

The FCC I think had it right. OK, people are buying this service, the broadband service. It's expanding dramatically. Privacy is now basically for sale across our country. And these are the most sensitive pieces of information about a family that can be obtained. So we're going to have to just continue to have a national fight over this issue because I think it's as fundamental an issue as we have in our country.

Thank you, Mr. Chairman.

Senator GARDNER. Senator Peters.

**STATEMENT OF HON. GARY PETERS,
U.S. SENATOR FROM MICHIGAN**

Senator PETERS. Thank you, Senator Gardner. And thank you to all of our panelists today for your testimony.

It's in my mind, before we embark on any kind of comprehensive infrastructure package, we need to have a real complete picture of the landscape that we're dealing with. And as many of you know, this committee passed the MOBILE NOW Act last January, which I think was an important step, one step of what will be many steps to help that and facilitate that knowledge.

One provision of the bill that would establish a database of Federal communications facility installations, in fact, I sponsored an amendment to that provision, which would require agencies to help states and localities contribute to this database with information about their own broadband assets. Having the database include Federal, local, and state data certainly will make it more comprehensive and a better tool for stakeholders to make these kinds of decisions.

However, this database only covers assets owned by Federal, state, and local governments. We still face challenges in understanding and mapping the scope of private assets, although sometimes it can be even easier to deploy broadband on private lands. And I believe private and public should seek to constantly learn from and help one another. And so the Federal Government should do everything possible certainly to streamline, but also needs private cooperation to understand how we can act more quickly.

So, Mr. Resnick, my question is to you. A report last year by the FCC's Intergovernmental Advisory Committee, which, of course, you chair, found that the FCC lacks the data on the location of

wireless towers and other facilities, the providers who use each tower, and other information that would streamline local and Federal decisionmaking.

So if you could take a moment and describe further the challenges that we face with collecting this data and creating the comprehensive map necessary for broadband service. And then also in your work, if you have seen any models that would be helpful in dealing with the situation?

Mr. RESNICK. Well, thank you, Senator. I do appreciate the question. And that is correct, that was an important component of the report that the IAC issued in, I think, December 2016, so it's recent.

We were actually quite stunned and surprised that the FCC did not have data as to what facilities were out there that would be available for collocation for providers to use. We just assumed this is an agency tasked to do this, and they're all specialists, and they spend a tremendous amount of time researching the industry and researching what facilities are existing, and they don't have any of this information.

And because there are several reasons. One, not all towers are required to be registered. There is only actually a very small percentage of towers that are required to be registered. It has to do with the location and the size of the towers. And often even the industry doesn't know what facilities are out there that might be possible for collocation.

There are some local governments that have in their local codes mandated that all providers and infrastructure companies register their facilities with the local governments. And there's usually no fee for such registration or a nominal fee just to cover the administrative costs with maintaining that database, and that has been useful, both for regulators and first responders who need to know where these facilities are as well as for the industry members that are looking to collocate equipment on these facilities. So I think that would be incredibly helpful throughout the entire country. And I'm sure National League of Cities and other government organizations could work with their partners to try and come up with models that might be appropriate for the Federal Government to look at. Thank you, sir.

Senator PETERS. I appreciate that. Any other panelists that would like to comment on that?

Mr. HENDRICKS. Just very briefly, Senator, I would say that I agree. Nokia is a major provider of the infrastructure and a partner in the FirstNet project that's going forward. We saw firsthand that it's very difficult sometimes to know what assets were out there, both land mobile radio towers, private towers, and other things, what state of readiness and whether they have been hardened.

That information, in our experience, exists in various places. There are system integrators that build networks for companies. There should be a model where we can cooperatively share that information and improve the picture, I think.

Senator PETERS. All right. Yes, ma'am.

Ms. COOPER. I would just like to add more generally that the knowledge of any transmitter is a valuable piece of information,

particularly as you expect different technologies to share spectrum, to operate, and co-exist. Whether that's the method that's applicable for every technology maybe remains to be determined, but I do think that the knowledge of locations is an important piece of the prospect of spectrum efficiency and sharing.

Senator PETERS. I appreciate it. Thank you so much.

**STATEMENT OF HON. DEAN HELLER,
U.S. SENATOR FROM NEVADA**

Senator HELLER [presiding]. Thank you, Mr. Peters.

Mr. Chairman, I think I yield myself 5 minutes. Thank you. There's a lot of temptation sitting at this seat to make a lot of decisions, but the biggest temptation is this muffin that's sitting right here in front of me. I'm quite sure you had that set up.

[Laughter.]

Senator HELLER. Anyway, I want to thank the panel for being here and taking time. A lot of good insight, a lot of good history, and I certainly know that this is an issue that's very important to my state, and I certainly appreciate the other Senator from Nevada that was here earlier and her questioning, and I know this is just as important to our Chairman here in South Dakota, as it is in the state of Nevada.

But I want to share real quickly, briefly, a success story that we have in the state of Nevada, and it's an electric company called Valley Electric Association. It's located in a small city just outside of Las Vegas called Pahrump. Most people do think of it as just an electric company, but they have a great story about their recent success in broadband deployment.

They partnered with a company out of Las Vegas called Switch, and I'm certain most of you are familiar with Switch, where they were able to run a 1-gig fiber optic line from Las Vegas to Reno. I don't know that I've heard of any other 1-gig fiber optic highways that run nearly 500 miles through some of the smallest rural communities that we have in the state. And I would argue that there aren't even urban areas in the state of Nevada that have this kind of access for their schools or hospitals and even some of their residents.

But Valley Electric helped engineer this path. They prepared the poles. They submitted the applications to get all this done. And it's because they saw a bigger picture. And this invitation that I had to spend time with them, they went through this, and the success that they were able to see. They do know this, that if communities don't have broadband, the people will leave, and that has been a concern for the rural portions of our state. You can't operate a school, you can't operate a hospital, or a business. We have communities in our state that you can't even swipe a debit card because they don't have access.

But the fiber route that they prepared is like a highway. And most of you are aware of this, you need off-ramps. And so they're building those broadband off-ramps, and they're facing some serious barriers. So they have the fiber, but it's the off-ramps now that are causing the problems, and they're problems that mostly come with the Bureau of Land Management.

Sandy Valley, Nevada, is a good example. They already have the electric lines that were permitted into that valley, they just need to add the cables for broadband, and that's taken 10 months filing the application, and yet after 10 months, they still do not have approval. Federal agencies like BLM are hamstringing private companies that are using their own money to invest and expand infrastructure into places no one else wants to expand.

Valley Electric will face the same challenges in Amargosa Valley; Beatty, Nevada; and every rural town that D.C. has probably never heard of, but ones that most of us have visited at one time or another in our own states.

I believe that people in these communities deserve broadband, and Valley Electric told me that the delayed applications from the Federal land agencies is the number one barrier to broadband deployment. So I have legislation I'm working on with the Chairman that will streamline the Federal permitting process.

Mr. Hendricks, you mentioned that in your testimony. And I appreciate your comments, and most important, to ensure that there's a shot clock that these Federal agencies have to abide by.

And, Mr. Weninger, you mentioned that in your own legislation back in Arizona and the difference that that made. I agree with you and believe that we should do that at the next level, which is our level.

So I guess I want to start with Mr. Downes and ask if these Federal agency complaints that I get from the state of Nevada, are they common across the country, the eastern and the western portions?

Mr. DOWNES. Yes. Thank you, Senator. And the funny thing is I think—my understanding is that much of the fiber infrastructure for California is actually built just on the Nevada side of the border because the California people made it even more difficult than in Nevada.

So there's no question that a lot of these delays have no public interest value whatsoever. And, again, shot clocks, even the shot clocks that exist right now in wireless, they're very generous in terms of how many days that they are. And I think, yes, certainly in the western United States in the intermountain region, where obviously most of the land or much of the land is federally owned, not surprisingly, the complaints you hear most are about Federal management.

Senator HELLER. Mr. Downes, is this an issue of process or is it an issue with resources, or is it just an accountability issue that we're dealing with, with some of these agencies?

Mr. DOWNES. Well, it's some of all of those. It really depends on who you're talking about and where you're talking about. In a lot of cases, there are no processes. In a lot of cases, certainly there is resource constraint as well. Obviously, Federal agencies, as well as municipalities, they don't really have competition per se. So if you're not getting your permits done as quickly as you would like from them, it's not like you're going to go somewhere else to get them. And I think that's actually where the solution comes in.

As I say, the best incentive is to buildup sort of competitive spirit. And we saw how Google did that so brilliantly in the initial roll-out of Google Fiber, getting all those cities to compete, not by offer-

ing money, not by offering tax incentives, but by offering to streamline their processes, a single point of reference, give access to city buildings and other property.

And I think as the states and the localities start to recognize the real economic opportunity that 5G and next-generation wired Internet provides, you're going to start to see more of that, that these locations will say, "We want that development here, we want to be leaders in that," and they will suddenly discover just how much better a job they can do even given the resource constraints that they have.

Senator HELLER. Yes, but my problem when I talk about process is with the government agencies themselves. It doesn't matter—Nevada is 110,000 square miles. It doesn't matter which community I go to, they will tell me that their BLM office is the worst when it comes to dealing with that, and I'm going to guess that it's true in any other state that I go to. But right now, I'll tell you that Pahrump believes that the office in Las Vegas is the worst in the country because they can't get these applications through.

How do we hold these agencies accountable?

Mr. DOWNES. So my experience, Senator, is certainly more at the local and state level, not with the BLM and other agencies. But, you know, you control the power of the purse, and that's where you can hurt them or get them where you want them. Again, minimum requirements for how quickly they deal with things, and penalties, I suppose, to the extent that Congress can implement them, for the agencies that just don't follow the rules that they're set up to do with their reasonable rules.

Senator HELLER. Now, Mr. Weninger, you served with my son-in-law in the legislature.

Mr. WENINGER. Yes, yes, I did. And I know your daughter.

Senator HELLER. Have you solved these problems in Arizona, the problems that we're seeing in Nevada? What processes did you go through, not only for your own legislation, but what did you do to overcome—because you have as much public lands as we do, at least close? How were you able to overcome some of these Federal agencies and able to implement some of the programs that you've been successful at doing?

Mr. WENINGER. It's difficult. Basically, ours probably isn't going to affect the BLM land. We will still have to deal with that. But one thing we did on the legislation, we put a shot clock within the shot clock. So you have to tell us within 20 days whether or not the application is complete or not because we don't want you running clear up to 70 days and say, "Well, no, we don't have everything." But then that's within the 75 days, so it's not in addition to. And so I think that helps a lot.

But we have the same problems you do. I think somebody else mentioned, it's because so much of our land is Federal land that we're kind of held captive by that in the West.

Senator HELLER. Thanks for the question. I sit in the Chair, so I get to go 8 or 9 minutes, right, Mr. Chairman?

[Laughter.]

Senator HELLER. Ms. Klobuchar.

**STATEMENT OF HON. AMY KLOBUCHAR,
U.S. SENATOR FROM MINNESOTA**

Senator KLOBUCHAR. All right. Thank you to both of you, and thank you. I apologize for being late. We had a Judiciary Committee hearing with FBI Director Comey, so I'll try to use the same tone with all of you that all the other Senators were using in that hearing. I'm just kidding.

[Laughter.]

Senator KLOBUCHAR. OK. So I have been pushing hard for a competitive agenda for this country, and I am so glad that we launched the Senate Broadband Caucus, which includes myself, as Chair, and Capito, King, Heinrich, and Boozman. And I really see broadband as the infrastructure challenge of our time.

My favorite story of the week was hearing when I was in northern Minnesota about a cancer doctor who for years when he couldn't be at the hospital and he would be sent something at home about a patient in some kind of urgent situation, he would have to go to the McDonald's parking lot to look at X-rays. OK, this happened in northern Minnesota in a pretty mid-sized town, not a small town. So those are the kinds of things we're encountering.

So we're pushing hard to get funding, whether it is changes to the universal service fund, whether it is this major broadband infrastructure discussion that we're having, and I've gotten both Secretary Mills and Secretary Chao to commit that it should be part of any infrastructure package. We're hoping we hear from the White House about specific infrastructure package. The Senate has a package that's a trillion dollars with a major Internet component. And I just think we need to get this done.

So I'm going to start with something more specific, and that is, I've advanced broadband legislation to make deployment easier by requiring transportation and broadband providers during construction to just dig once, and this legislation passed the Commerce Committee in the MOBILE NOW Act, it passed in January.

Mr. Downes, you testified that "Dig Once" policies can reduce the cost of deploying fiber under highways in urban areas by up to 33 percent and up to 16 percent in rural areas. Would those kind of savings make some high-cost areas more economical to serve?

Mr. DOWNES. Absolutely. And thank you, Senator Klobuchar. It's good to see you again.

So, look, I can't think of any reason, and I can't find anybody who doesn't agree with the idea of "Dig Once." It really just makes so much sense. And those numbers that I gave in my testimony came from the GAO. I think they're quite solid. So absolutely, we bring down the cost by putting that conduit in place. Then we can put the fiber in. It can only be to a benefit. I can't think of any reason not to do it.

Senator KLOBUCHAR. OK. Thanks. Something else, I just keep looking for ways to show, especially some of our urban friends, that the gap that we're seeing is in rural areas. And yet cost of living in rural areas are lower. There are reasons we want to have people just live throughout our country and not just in congested areas. And we also have a lot of cool businesses being developed there, and that has been the heart of our economy, the way we're able to

develop small businesses and then they grow, but they can't without broadband.

I was actually at one business in a small town where there is not good enough broadband, and she's up to 25 employees. She makes chains for chain jewelry. She has to have her sales staff located 100 miles away or so in Fargo because they have Internet there, and so then she's able to communicate with them by phone.

So Senators Capito and Sullivan and I have introduced this bill to conduct an analysis of the effects of broadband deployment and adoption in the U.S., asking the Commerce Department to do that.

Mr. Resnick, with your experience with the National League of Cities, would better economic data help mayors and other community leaders make the case for investing in broadband deployment?

Mr. RESNICK. Thank you, Senator. Yes, absolutely. We're always trying to measure the economic development effects of infrastructure. It's not something that a lot of local governments are easily accomplished to tackle. And so if the Federal Government could support that effort, absolutely. If we could show the benefits of broadband technology in terms of our economic development, I think it would encourage investment, not only by local governments and state governments, but also probably by the private sector as well. Thank you.

Senator KLOBUCHAR. OK. Thank you very much.

This one is for you, Mr. Hendricks. Broadband infrastructure deployment can often be hampered by slow and redundant permitting processes, particularly when it comes to infrastructure siting on Federal lands. For those rural and tribal residents living near Federal land, this inefficient process can be the difference between living in an unserved community and modern broadband access.

I've been working to streamline this process, and there are some provisions in this MOBILE NOW bill I just referred to that would improve permitting and encourage deployment on Federal lands by developing a common form for applications and establishing a clear point of contact with Federal agencies.

Could you talk about some of the primary obstacles that the broadband service providers that your company works with face when trying to deploy broadband infrastructure on Federal lands?

Mr. HENDRICKS. Well, to be fair, I think we have much more experience when it comes to deploying in city centers, but we do obviously work with providers across a range of jurisdictions. You've noted several provisions in the MOBILE NOW Act. By the way, we fully support all of those provisions that you have put in there.

Shot clocks, response times, the requirement for individual applications for individual cells as opposed to figuring out a way to aggregate and consider multiple sites at a time, which also requires you to do multiple impact studies, those things begin to layer in cost. And so we certainly support the idea of shot clocks and taking a look at other ways to incentivize, perhaps even making clear to BLM and others that, "You have this authority. Use it or lose it. You know, at some point, we're going to deem granted some of these applications if you don't give the proper attention to them."

Senator KLOBUCHAR. OK. Very good. I note that most of the rest of my questions, they say, "Senator Nelson asked this," "Senator Cortez," so I will not use the usual Senator theme of just being re-

dundant anyway, and I will turn this over to Senator Blumenthal, my colleague. Thank you, all of you.

**STATEMENT OF HON. RICHARD BLUMENTHAL,
U.S. SENATOR FROM CONNECTICUT**

Senator BLUMENTHAL. Thank you, Senator Klobuchar. I, too, will try to avoid being redundant. I know you've been asked a lot of questions about net neutrality and some about broadband privacy. The threat to net neutrality and privacy on the Internet I think are two of the most profound challenges we face. They've been set back in recent weeks by Republican colleagues, by pronouncements from Chairman Pai, and by President Trump, which, in my view, have undermined essential values of both privacy and open Internet that are key to investment in broadband.

According to a recent study by the Pew Research Center, 91 percent of adults agree or strongly agree that, quote, "Consumers have lost control of how personal information is collected and used by companies." Another study found that nearly half of American Internet users avoid online activities, including online purchases and civic activities due to their security and privacy concerns. That apprehension on the part of Americans certainly inhibits investment in broadband, in infrastructure, in all of the communications technology that is vital to our future economically, not to mention in quality of life.

So let me ask you, Mr. Hendricks, do you think that these threats to privacy are good for investment in the Internet, or, on the contrary, are obstacles?

Mr. HENDRICKS. One of the things that Nokia, as a technologist, thinks a lot about is where we will be in the next 5 to 10 years with the Internet of Things and the connected programmable world. And we talk a lot about trustworthiness as an important metric for people in uptake and use of those technologies because more and more of those technologies are going to require you to put more and more of your physical, financial, and personal life at risk. And so it is something that we think a great deal about. We are constantly talking in the design of our products, how do we make them more secure by design? How do we incorporate privacy protections? And I think we've contributed a lot to the policy conversation in town about how you do that.

I think the one thing that I hope comes out of our participation in that debate is we think that it is a good thing to talk about enhanced privacy protections regularly. Our big concern with what the FCC did was that it began to make distinctions between sectors of this ecosystem who could use information one way and not another.

And so I think our concern is let's take a fresh look at how we can potentially improve privacy protections across all sectors because we don't yet know how this marketplace is evolving. Service providers are becoming content providers, edge companies are become service providers. We have to make sure that we develop these protections robust but technology-neutral.

Senator BLUMENTHAL. Well, I've introduced a bill, it's called MY DATA, the Managing Your Data Against Telecom Abuses Act, along with Senator Udall. It endeavors to protect this data by ena-

bling the public sector and the government to be more effective in protecting this kind of data and enhancing confidence in exactly the systems that you just mentioned. The legislation ensures that the FTC's jurisdiction in the Internet ecosystem includes broadband providers, a loophole that now exists in the current law. And I hope that members of this panel and the companies and interests you represent will support this legislation because I think it's important to your interests, the public's interests, the industry's interests, and restoring consumer privacy and data security across all Internet platforms. So thank you very much for being here today.

Thank you, Mr. Chairman.

The CHAIRMAN [presiding]. Thank you, Senator Blumenthal.

It has been a great discussion, and we really do welcome and appreciate your input. I think this lends a lot to the conversation that we're having about the best way to increase a more rapid deployment of this technology across the country so that we can pursue not only high-speed Internet services and broadband in areas of the country that don't receive it today, but as we look at 5G and everything we need to do to stay ahead of the curve there, we want to get there first, and that requires obviously an awful lot of work at every level of government. And so we've heard from several state and local leaders today as well as those that are working in the industry to make all this happen.

A final question just to close it out, in MOBILE NOW, as you probably know, we address some of the issues regarding deployment and Federal agencies. I'm wondering if there is anything that Congress can do to get folks to work together in delivering broadband services to our communities in a reasonable amount of time in addition to what we're doing with respect to the Federal piece of this in the MOBILE NOW bill? So any final pieces of advice or suggestions as we try to move quickly in putting policies in place and creating conditions that are favorable to the build-out that we need to see?

Yes, Ms. Cooper.

Ms. COOPER. The frequencies that are enormously valuable—K band, Ka band, and V band—the rules for many of these frequency bands that will carry next-generation broadband services, including by satellite, are immature and, in some cases, out of date, and it's very important to ensure that as those rules and allocations are considered, that the technologies that can reach Americans with broadband are considered as part of those allocations. We consider satellite to offer real promise for broadband access, and we want to make sure that in those bands, satellite services are considered. Thank you.

Mr. DOWNES. Senator, I would just add, I know we weren't talking specifically about spectrum today, but obviously, as you know, the most valuable now spectrum that's available that's underutilized or unused is held by Federal Government agencies, and we need to do a much better job of offering the right kinds of incentives, the right kinds of carrots and sticks, to get some of that either shared or freed up for next-generation applications.

Mr. HENDRICKS. I would add to that, Mr. Chairman. I'm sure that Members of the Senate are tired of hearing of the spectrum

issue because it seems like every year you get a wish list from industry about doing spectrum things.

As technologists, the reason that spectrum remains an important and critical topic on an ongoing basis is because the more bands that are made available to us, as researchers and developers of the technology, the more flexible the infrastructure is that we can develop for carriers of all size, rural ones, large ones. Different bands with different characteristics have different deployment scenarios.

So continuing to work on spectrum—and you’ve been excellent—is a core priority. So passing MOBILE NOW is a great step because of the 3-gigahertz spectrum that is in there, but I would encourage you to keep thinking and keep working on those spectrum issues because the more options you give us, the better the solutions we can develop will be.

The CHAIRMAN. It does seem like almost every issue that comes in front of this committee comes back to that issue of, how do we get more spectrum? So thank you.

Mr. Weninger.

Mr. WENINGER. Mr. Chairman, thank you. I think you’re off to a great start. And obviously I’m pretty proud of the legislation that a big team of ours put together, and if you use any of that on a national level, I think that would be incredible.

I think some people just don’t realize how quickly some of these companies and apps are scaling. And so I think it’s very tough for the cell phone companies to predict, and they just need to keep building. I own restaurants, and right now food delivery through an app is exploding. We have four different companies that we do it through, and it’s adding onto our revenue every day.

Also in my district, we have four different autonomous vehicle companies working in my district, which is mainly Chandler, and that’s going to be on the same platform. And these things are coming so fast that if we don’t really hurry this up, we’re going to be left way behind the eight ball. Thank you.

The CHAIRMAN. Thanks.

Mr. RESNICK. And, Mr. Chairman, thank you again for the hearing today and for inviting us to participate. I would just request that local governments be part of the process in developing these policies. Ultimately, if facilities are going to be deployed, whatever type of facilities, from the small device that my colleague here showed you—I was actually going to bring a model of the 28-cubic-foot cabinets that another company wants to install on our rights-of-way, but I couldn’t get it on a plane. And I was going to have a blow-up model of it brought in, but that wouldn’t have probably worked very well.

But, so they’re not always so small. There are other—that’s the problem with advances in technology, it’s not all the same, and local governments have to deal with these different types of technology that are now looking for access to the rights-of-way. I do not want a 28-cubic-foot refrigerator sitting on the sidewalk in front of my house, no offense. I don’t think you would want that either. So we do have to be part of the process to come up with solutions.

And I do want to support, though, the comments that some of your Senator colleagues made today. There does need to be confidence in the technology. Broadband is a great technology, but it

can be used for inappropriate purposes. I think every local government in the country by now has had a data breach, and they're tremendously disruptive. When our data is breached by somebody accessing our databases, our employee records, our customer records, tremendous impacts. The City of Fort Lauderdale shut down for 3 days because its internal data was breached.

So I think there does need to be greater confidence in the technology so that these inappropriate uses of broadband do not occur, and I think that would go a long way to support adoption. Thank you again.

The CHAIRMAN. Thank you.

**STATEMENT OF HON. JERRY MORAN,
U.S. SENATOR FROM KANSAS**

Senator MORAN. Mr. Chairman, I detected a groan when I walked in the room—

[Laughter.]

Senator MORAN.—not necessarily by the witnesses, but by others, and including you.

[Laughter.]

The CHAIRMAN. I thought I had my mike turned off. Sorry.

[Laughter.]

Senator MORAN. So I will submit my questions in writing, Mr. Chairman.

The CHAIRMAN. All right. Thank you, Senator Moran. That was not a collective groan about you, but nonetheless, we appreciate that. We'll make sure that your questions are answered for the record.

And I would just say to our witnesses, again thank you for being here. And we will keep the hearing record open. You will get questions for the record, and if you could respond to those as quickly as possible, we usually like to try and get that closed out within a couple weeks' time, that would be most appreciated.

So with that, thank you again, and we'll continue this conversation/discussion. Hopefully it will lead beyond just a discussion, but really substantive steps forward in terms of how we address these issues and try and find that balance that was discussed today, work with the various entities of government to streamline, expedite, and make it easier to get this technology out there and all the benefits that come with it.

So thank you. This hearing is adjourned.

[Whereupon, at 12:16 p.m., the hearing was adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JERRY MORAN TO
PATRICIA COOPER

Question. As your written testimony states, next generation satellite systems have vastly improved their capacity, lowered latency rates, and met equivalent pricing to their terrestrial broadband-providing competitors in recent years.

Can you explain the importance of taking a “technology-neutral approach” in any comprehensive infrastructure or tax legislative package considerations by this Congress and Federal regulating agencies?

Answer. SpaceX sees great potential for constellations of satellites operating close to the earth to deliver reliable, high-quality broadband service to consumers throughout the United States, including those areas that have been underserved or not served at all. However, programs to encourage broadband infrastructure build-out and service adoption often don’t capture satellite technology.

By covering the entire globe, such constellations can overcome the “last mile” connectivity challenges such as terrestrial build-out costs, environmental regulations, property rights issues, and other regulatory obstacles. The satellites can “see” customers, no matter where they are, whether urban or rural, at the same nominal incremental cost to add any customer for broadband service.

The deployment of U.S.-based satellite broadband constellations are, fundamentally, national infrastructure projects, even though they are private-sector driven and many components of the infrastructure will be in space. Although satellite constellations have different network elements than traditional ground-based networks, such as fiber, fixed wireless or mobile broadband, we urge Congress and the Administration to ensure that the nation’s programs and incentive tools for broadband infrastructure build-out are extended to space-based constellations. Given heightened Congressional and Administration emphasis on rural high-speed Internet access and broadband infrastructure, the time is ripe for Congress and Federal agencies to reconsider how satellite-based systems can participate.

Beyond defining the network elements that qualify for programs, other program requirements can unintentionally exclude satellite-based solutions. For example, grant programs that require technical support in every county where service is offered are unworkable not only for satellite broadband providers, but for any regional or national service provider. The National Broadband Mapping system, too, should capture data about satellite-based broadband services made available nationwide. This would not only enhance the understanding of our broadband landscape, but also provide a more accurate basis for shaping future broadband programs designed to expand broadband access for all citizens.

SpaceX encourages the Committee to ensure that satellite-based broadband infrastructure is considered and genuinely captured in any infrastructure, incentive, or tax policy legislation undertaken toward expanding broadband access in the United States. Such an approach will ensure that Congress and regulatory agencies consider all technology platforms available to deliver broadband to American consumers.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. DAN SULLIVAN TO
PATRICIA COOPER

Question. During the hearing, we talked a lot about the need to streamline the infrastructure permitting process for next generation technology, especially for deploying 5G technologies. In many parts of Alaska, however, there still is no connectivity, and the most realistic solution for many of these places is communications brought to them by satellite.

a. Ms. Cooper, what opportunities does satellite technology bring to rural communities, such as in Alaska, for receiving broadband?

b. What deployment barriers does the satellite industry face in deploying these new technologies, and what solutions do you propose, specifically where can Congress help in reducing those barriers?

Answer. Satellite-based Internet infrastructure can bridge the broadband access challenges that many rural and remote American communities face. SpaceX is developing a broadband constellation that will offer high-speed, low-latency, affordable broadband services to consumers across America, regardless of where they are. The service will include continuous broadband coverage for Alaskans even in the northernmost areas of the state, following the deployment of satellites in a specific near-polar orbit. The SpaceX system, which will begin deployment in 2019, is designed to offer fiber-like speeds at a competitive price direct to consumers. This means that consumers throughout Alaska—even in Arctic latitudes—will have available the same competitive broadband services, with speeds, latencies, and pricing equivalent to terrestrial, using the same SpaceX laptop-sized user terminals that will be offered elsewhere in the Continental U.S. By removing the “cost-per-mile” construct of connectivity, satellite constellations operating close to the earth can make high-quality, low-latency, affordable broadband to consumers who have never been connected, and also inject competition to those who are served currently by only one provider.

More could be done to enable the development and deployment of this sort of Internet infrastructure in space, and more Americans could be have access to broadband.

1. Overhaul outmoded and inefficient regulatory processes for the launch services needed to deploy satellite constellations. The Federal Aviation Administration (FAA) regulations governing commercial space launch should be streamlined and modernized to keep pace with more frequent commercial launches anticipated in support satellite constellations and overall industry growth. Similarly, the Federal Communications Commission (FCC) should act on its long-pending Notice of Proposed Rulemaking (“NPRM”) designed to formalize co-primary allocations of Federal frequencies already commonly used for commercial launch. Such an allocation would allow the FCC to streamline and expedite licenses for commercial launch spectrum as the cadence and complexity of U.S. launches grows along with the deployment of satellite constellations.
2. Build in rewards for satellite systems that are built for spectrum efficiency. Advanced spacecraft and ground technologies yield high levels of spectral efficiency and operational flexibility, yielding greater capacity to reach more unserved Americans with reliable, high-speed broadband. Highly intelligent and flexible satellites also can interoperate with multiple similar systems, while still protecting existing space and terrestrial networks, adding to the competitive marketplace. Unfortunately, not all such proposed systems are making the needed technology investments for efficient use of spectrum, in effect hampering sharing of available spectrum compared to other more adaptable constellations. At present, the FCC has no mechanism for rewarding more efficient satellite systems for their investment in advanced and spectrum-friendly technologies or penalizing those systems that do not. Congress and the FCC should encourage rules that incentivize and reward use of spectrally-efficient satellite systems and technologies, with the goal of equitable access to spectrum, preventing spectrum warehousing by non-operating satellite systems, and promoting and accommodating multiple satellite constellations that can coordinate and operate while serving American consumers.
3. Ensure that any broadband infrastructure or incentive programs are technologically neutral, allowing satellite broadband alternatives to qualify. This means finding parallels between elements of satellite and terrestrial networks so that satellite-based solutions can qualify for national infrastructure investment programs and other Federal initiatives to close the digital divide. Beyond defining the network elements that qualify for programs, other program requirements can unintentionally exclude satellite-based solutions. For example, grant programs that require technical support in every county where service is offered are unworkable not only for satellite broadband providers, but for any regional or national service provider. The National Broadband Mapping system, too, should capture data about not only enhance the understanding of our broadband landscape, but also provide a more accurate basis for shaping future broadband programs designed to expand broadband access for all citizens.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MAGGIE HASSAN TO
PATRICIA COOPER

Question. It's clear there is major interest in improving access to broadband and the way we deploy broadband services. This national goal transcends party lines, and I'm pleased to be a part of this committee where I can work with colleagues on both sides of the aisle to make improvements. I would like to hear from you all, what is being done, and what *more* should be done to ensure rural Americans are not left behind as technology evolves and innovations emerge. Rural America is more complex and difficult to connect for many reasons, but every American should have the opportunity to reap the social and economic benefits of broadband connectivity. What are your thoughts?

Answer. Satellite-based Internet infrastructure can bridge the broadband access challenges that many rural and remote American communities face. SpaceX is developing a non-geostationary satellite orbit ("NGSO") broadband constellation that will offer high-speed, low-latency, affordable broadband services to consumers across America, regardless of where they are. The SpaceX system, which will begin deployment in 2019, is designed to offer fiber-like speeds at a competitive price direct to consumers. By their nature, the satellites "see" end-users from their position in low-Earth orbit, regardless of whether they are urban or rural, at the low incremental cost of simply installing a roof-top terminal. By removing the "cost-per-mile" construct of connectivity, satellite constellations operating close to the Earth can make high-quality, low-latency, affordable broadband to consumers who have never been connected, and also bring a competitive offering to those who are served currently by only one provider.

More could be done to enable the development and deployment of this sort of Internet infrastructure in space, and more Americans could have access to broadband.

1. Satellite-based broadband networks should be captured in any infrastructure, incentive, or tax policy legislation undertaken to expand broadband access in the United States. Such an approach will not only maintain a technology-neutral approach to infrastructure, but also position American consumers to benefit from the significant innovations and nation-wide connectivity of next-generation satellite-based broadband.
2. The regulatory framework for NGSO satellite constellations is outdated and incomplete. The Committee should promote decisive updates in Part 5 and 25 of the Commission's Rules that clarify how constellations must share spectrum with each other efficiently, and enable incremental deployment of the constellations to track with emerging demand. This should include regulatory incentives which encourage the use of spectrally-efficient technologies in satellite broadband constellations. At present, the FCC has no mechanism for rewarding more efficient systems for their investment in advanced and spectrum-friendly technologies.
3. In order to provide needed broadband connectivity, such satellite constellations will also require multiple launches to deploy the satellites into space. Congress should strongly encourage the FCC to finalize its long-pending rulemaking to allocate spectrum for commercial launch services. This effort is a timely and important step for the Commission to adjust to the increasing cadence and complexity of launches and growth in number of U.S. launch service providers.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. ROGER WICKER TO
LARRY DOWNES

Question 1. An essential part of reducing barriers to broadband deployment and increasing investment in broadband infrastructure is having an accurate understanding of what areas across the United States remain underserved or unserved. As you mentioned in your testimony, previous efforts to provide service to underserved or unserved areas have resulted in wasteful spending and overbuilding.

a. What can Congress and the FCC do to ensure that Federal investments in broadband infrastructure are going to areas that are truly underserved or unserved?

b. How can we standardize data collection processes to ensure that we have an accurate understanding of what areas remain underserved or unserved by mobile broadband coverage?

Answer. There are several gaps in the data available on broadband deployment. The National Broadband Map has not been updated since 2014, and the FCC has no current plans to update it.¹

A second overarching problem is the misguided decision the agency made in 2015 to change the definition of broadband to a 25 Mbps download speed and a 3 Mbps upload speed.² Even today, these speeds, though admirable goals, are much greater than what is actually needed by consumers to enjoy nearly all Internet services, including the streaming of high-definition video.

As a result of these failings, data suggesting where and for whom broadband access in the U.S. is incomplete may be highly misleading. That in turns means that upcoming decisions both at the FCC and in Congress on how to deploy additional resources to close what remains of the digital divide may be driven by faulty analysis, leading to poor decisions and, ultimately, a failure to provide assistance where it is truly needed.

These problems need to be addressed before any future decisions on taxpayer resource deployments are made. The National Broadband Map should be updated and a sustainable process for keeping it current adopted. The FCC should also revisit—using technical rather than political criteria—its definition of what download and upload speeds constitute “broadband,” or even whether speed should be sole basis for defining broadband service.

At a more nuts-and-bolts level, there are other well-known issues with how the FCC and other government agencies determine and report broadband availability and performance. As you noted last week at a hearing on the Universal Service Fund and Rural Broadband Investment:

Inadequate data collection methods are also one of USF’s challenges, leading to an inefficient distribution of funds to truly underserved and unserved areas. To address this issue, I recently joined Senator Manchin in introducing the “Rural Wireless Access Act,” which has the support of several of my colleagues, including Senators Schatz, Fischer, Klobuchar, Moran, and Peters. This bill would require the FCC to standardize its data collection methods to ensure that USF support is directed to rural communities—in Mississippi and across the nation—that are actually in need.

Reliable data is a critical step toward eliminating inefficiencies within the USF program and fulfilling the statutory goal of universal service. I appreciate the efforts of all stakeholders involved to improve data collection at the FCC. As these efforts continue, it is important that this data be collected quickly so as not to delay the delivery of essential communications services, through programs like Phase II of the Mobility Fund, to communities in need.³

(a) Setting these definition and measurement issues aside, we know there are only a small number of U.S. census tracts that currently have no broadband provider. As I noted in my testimony, I believe an economic case for deployment in these areas will remain difficult for private providers to make, and that therefore these should be the focus of any direct investments Congress includes in future infrastructure spending.

That, I believe, is the best hope for ensuring federally-supported investments in broadband infrastructure are going to areas that are truly underserved or unserved. As I noted:

Any direct infrastructure spending Congress approves should be targeted exclusively to the few remaining census tracts, mostly rural and tribal, where there is currently no competitive broadband service. Congress should consider setting aside a modest portion of its proposed infrastructure fund, say \$20 billion, for a one-time rural broadband acceleration program.

Network operators would be offered subsidies to build out in these extremely high-cost areas, with a requirement to use technologies with sufficient bandwidth to support substantial future growth, perhaps up to 100 Mbps speeds. Calculation of specific subsidies should be made on a per-location basis, determining as precisely as possible how much is needed to overcome otherwise prohibitive build-out costs.

¹See FCC, National Broadband Map, available at <https://www.broadbandmap.gov/>.

²See FCC, 2015 BROADBAND PROGRESS REPORT, GN Docket No. 14–126, January 29, 2015, available at <https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2015-broadband-progress-report>.

³Statement of Chairman Roger Wicker, Senate Subcommittee on Communications, Technology, Innovation, and the Internet, hearing on June 20, 2017, available at <https://www.commerce.senate.gov/public/index.cfm/hearings?ID=628B02EB-3D8D-4356-B0E9-5F4BC4B5A312>.

Funds for the acceleration program, moreover, should come from general appropriations rather than raising the already-unsustainable fees consumers pay into the Universal Service Fund, which today represents a 17.4 percent cost added to voice services.⁴

To avoid problems that plagued the Recovery Act's scattered broadband initiatives, moreover, the acceleration program should be managed by one agency, with strict controls to help ensure troubled projects get attention (or cut off) sooner rather than later. Between the National Telecommunications and Information Administration, Rural Utilities Service, and the FCC, there is consensus that the FCC does the best job at maximizing its deployment-related funds, and should be the sole agency responsible for the acceleration fund, albeit with added controls to reduce waste and abuse.

(b) Solving the more specific measurement and consistency issues is entirely within the technical capability of the FCC, but the agency has in recent years had a strong disincentive to do so. Eager to activate authority the Commission incorrectly believed was inchoate in the Communications Act and in particular in Section 706(a) and (b), the FCC has in recent years adjusted definitions and manipulated measurement data to emphasize failures in broadband deployment, both wired and mobile. For years, the agency refused even to consider mobile broadband as a source of broadband at all, arguing weakly that it had inadequate data to measure it.⁵

Why has the FCC engaged in such counter-productive behavior? By failing to answer or answering negatively Congressional mandates to determine whether markets are competitive, and by torturing the data to find that broadband was not being deployed "in a reasonable and timely manner" overall, the FCC justified many of its recent interventions into the broadband market.

While the interventions skewed private broadband investment decisions, the misreporting has made it impossible for Congress, the agency or others to develop an accurate understanding of the true state of the broadband market and in particular where problems in coverage remain.

Given the considerable resources the FCC devotes today to its data collection and reporting requirements, this is truly a lose-lose state of affairs. As I noted in earlier testimony:

As Ronald Coase famously wrote, "If you torture the data long enough, nature will always confess."

That, in a nutshell, has become the FCC's unintended modus operandi. The agency collects the data it needs to make wise and efficient decisions, but in the absence of clear guidelines and the most basic economic analysis, the Commission cannot resist the temptation to abandon the logical conclusions compelled by that data in the service of vague, idiosyncratic, transient and, often, unarticulated policy goals. The lack of structure wastes both government and private resources. Worse, it vastly under emphasizes the likelihood that imminent technology disruptors will better and more efficiently advance the communications needs of American consumers with far fewer unintended consequences.

These problems devalue much of the good work of the agency's staff and subvert the often-admirable goals of the FCC's Chairmen and Commissioners. They have created an epidemic of negative side-effects, including:

- Many of the agency's reports fail to reach obvious conclusions supported by the thorough data collection the agency performs, limiting their usefulness as policy tools to advance the FCC's longstanding charter to promote communications to all Americans.

⁴ See FCC, *Contribution Factor and Quarterly Filings—Universal Service Fund Management Support*, available at <https://www.fcc.gov/general/contribution-factor-quarterly-filings-universal-service-fund-usf-management-support>.

⁵ See, e.g., Larry Downes, *How the FCC Sees Broadband's 95 percent Success as 100 percent Failure*, FORBES, Aug. 13, 2012, available at <https://www.forbes.com/sites/larrydownes/2012/08/23/how-the-fcc-sees-broadbands-95-success-as-100-failure/#6e324b6dbe55>. Even in the most recent Broadband Progress Report, the FCC still refuses to adopt measurement and reporting tools that show intermodal competition between wired and mobile broadband services. See FCC, *2016 Broadband Progress Report*, GN Docket 15–191, Jan. 29, 2016, available at <https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2016-broadband-progress-report>.

- Rulemakings torture their analysis and data to justify what appear to be ex ante conclusions to regulate—regardless of the need or cost. . . .⁶

To overcome these problems, Congress must realign the agency's incentives and require the agency to collect and report accurate information, allowing its technical experts to define and collect neutral and useful standardized data.

Your proposed legislation, S. 1104, "The Rural Wireless Act of 2017,"⁷ would go far toward resetting the balance, requiring the FCC to make its measurements based on good science rather than bad politics. I would recommend extending those common-sense principles beyond measurement of mobile broadband to wired services as well. I also continue to support consolidation of FCC reporting, both to reduce duplication and to remove unhelpful data silos between different bureaus within the agency.

More broadly, however, Congress should remove any lingering temptation for the FCC to perform incomplete, inaccurate, or artificially pessimistic data collection and analysis of broadband market conditions. That could be accomplished by legislation making clear that Congress never intended Section 706 as an independent grant of agency authority, let alone one that triggered special powers based on particular negative findings about the state of broadband competition or availability.⁸

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JERRY MORAN TO
LARRY DOWNES

Question 1. According to the recommendations included in your written testimony, you support the idea of a single Federal agency "with strict controls to help ensure troubled projects get attention (or cut off) sooner rather than later" in rural broadband acceleration considerations for future comprehensive infrastructure legislation.

a. Given the existing expertise at the FCC, would you agree that the FCC is the best place for the broadband infrastructure conversation to take place?

b. What criteria do you suggest we consider in evaluating choices for the creation of any broadband infrastructure investment plan?

Answer. (a) I have not made a comprehensive evaluation of either the corporate finance or project management expertise within the FCC, or its strengths in those areas relative to other Federal agencies and departments, notably the NTIA and the USAC. A careful and neutral evaluation of those capabilities and recommended improvements, however, would be essential before Congress authorizes any additional taxpayer funding to ensure both professional and efficient disbursement of grants, loans, and other resources.

However, as I noted in my testimony, it is clear from both private investigations as well as those of the GAO that funding provided through the 2009 Recovery Act was not as effective as it could have been, and in many examples resulted in broadband project spending that was either unnecessary or, worse, which was never completed.⁹

These reports singled out the performance of the Rural Utilities Service as being especially poor. I am unaware, however, of reforms that may or may not have taken place at RUS following the recommendations of GAO or others.

I do believe, however, that any future Federal investment would be best coordinated by a single agency. The FCC, if nothing else, has the most experience and the most appropriate Congressional mandates to advance broadband deployment and adoption goals within the Federal Government. The FCC also has the benefit

⁶See Written Testimony of Larry Downes, *Hearing on FCC Process Improvement*, Before the Subcommittee on Communications and Technology, Committee on Energy and Commerce, U.S. House of Representatives, July 11, 2013, available at <http://docs.house.gov/meetings/IF/IF16/20130711/101107/HHRG-113-IF16-Wstate-DownesL-20130711.pdf>.

⁷See <https://www.congress.gov/bills/115/congress/senate/bills/1104/text/r=2436>.

⁸That clarification was proposed, for example, in draft legislation circulated in 2015 by Chairman Thune along with Chairmen Walden and Upton in the House. See Larry Downes, *Eight Reasons to Support Congress's Net Neutrality Bill*, THE WASHINGTON POST, Jan. 20, 2015, available at https://www.washingtonpost.com/news/innovations/wp/2015/01/20/eight-reasons-to-support-congress-net-neutrality-bill/?utm_term=.874a52ca1c05.

⁹See, e.g., Testimony of Ann C. Eilers, Principal Assistant Inspector General, DOC OIG before the House Energy & Commerce Committee's Subcommittee on Communications and Technology, *Is the broadband stimulus working?*, Feb. 27, 2013, available at <https://www.oig.doc.gov/OIGPublications/OIG-13-017-T.pdf>; Government Accountability Office, *Recovery Act: USDA Should Include Broadband Programs Impact in Annual Performance Reports*, June, 2014 at page 22; Tony Romm, *Wired to Fail*, POLITICO, July 28, 2015, available at <http://www.politico.com/story/2015/07/broadband-coverage-rural-area-fund-mishandled-120601>.

of being the author of the visionary 2010 National Broadband Plan, which retains considerable value as a planning and evangelizing document.

Finally, as noted in my testimony, the FCC has in recent months initiated proceedings specifically aimed at improving deployment opportunities for broadband in rural areas.

Absent any findings of structural problems internal to the FCC that would make it unable to effectively manage future Federal broadband initiatives, I do believe the Commission is the best place to coordinate the on-going broadband infrastructure conversation.

(b) Without knowing specific legislative goals and proposed funding levels, it's difficult for me to advise the Committee on criteria for choosing between competing investment options and proposals.

However, as I noted in my testimony, I share the non-partisan view of many analysts that our remaining digital divide is driven by both availability and adoption problems that disproportionately affect rural, older and less-educated Americans. Any broadband infrastructure plan adopted by Congress should focus on identifying the specific reasons for these gaps, and target spending and resources accordingly.

I recommended limited and carefully controlled direct investment, targeted exclusively to the few remaining census tracts, mostly rural and tribal, where there is currently no competitive broadband service.

These should take the form of subsidies to build out in these extremely high-cost areas, with a requirement to use technologies with sufficient bandwidth to support substantial future growth, perhaps up to 100 Mbps speeds. Calculation of specific subsidies should be made on a per-location basis, determining as precisely as possible how much is needed to overcome otherwise prohibitive build-out costs.

I also recommend severely limiting ongoing support. To date, the FCC provides payments in the form of small ongoing annual subsidies, even in areas when all that was needed to overcome high infrastructure costs was an initial capital investment. Because of this approach, it can take years for providers to recoup their own capital investments, unintentionally encouraging operators to build piecemeal in rural areas, and to make decisions based on what providers believe the government will fund rather than on what consumers want.

Future investments should avoid this error by offering instead carefully-calculated one-time subsidies. This will save billions in ongoing costs. While some truly high-cost areas will continue to need both start-up capital and operating support, the emphasis for any new rural broadband infrastructure spending should be on those locations for which capital alone can overcome the need for further government subsidy. This will deliver the most bang for scarce taxpayer bucks.

After determining the optimal per-location subsidy needed, the government may find there are more providers willing to build in underserved rural and tribal areas than there are funds to support them. If so, the FCC should be authorized to run a reverse auction among competing providers to bid down the per-location cost.¹⁰

To address equally entrenched adoption problems, I also recommended addressing causes of the digital divide unrelated to either availability or price.

As the most recent data from the Pew Research Project shows, we are winning the battle to reduce broadband cost for those least able to afford it. In addition to expanded Universal Service programs and the shift from voice to broadband for Lifeline and other programs, leading Internet providers, including Comcast, AT&T and, recently, Sprint, have expanded programs aimed at low-income families, signing up millions of new Internet users for roughly \$10 a month.¹¹

As the adoption gap narrows, however, we need new strategies that target different problems. Availability and price are no longer the most significant factors holding back the 13 percent of Americans who remain offline. Consistent with finding over the last decade, the Pew Research Center noted recently that only 19 percent of offline adults cite the expense of Internet service or owning a computer as a barrier.

Instead, “[a] third of non-internet users (34 percent) did not go online because they had no interest in doing so or did not think the Internet was relevant to their lives.” Researchers reported. “Another 32 percent of non-internet users said the

¹⁰See Blair Levin and Carol Matthey *In Infrastructure Plan, a Big Opening for Rural Broadband*, Brookings Institution, Feb. 13, 2017, available at, <https://www.brookings.edu/blog/the-avenue/2017/02/13/in-infrastructure-plan-a-big-opening-for-rural-broadband/>.

¹¹Larry Downes, *The Digital Revolution Has Not Reached All of Us*, THE WASHINGTON POST, August 31, 2016, available at <https://www.washingtonpost.com/news/innovations/wp/2016/08/31/the-internet-revolution-has-not-reached-all-of-us/>.

Internet was too difficult to use, including 8 percent of this group who said they were ‘too old to learn.’”¹²

While income undoubtedly continues to play a significant role in non-adoption, in other words, many who remain offline wouldn’t use the Internet even if it were free. This conclusion was also reached by a recent NTIA survey, which found that over half of those who don’t have Internet service at home—again, largely rural and older Americans, and those with less education—say they just don’t want or need it.¹³

Part of this resistance comes from the fact that unconnected Americans don’t know how to use a computer or even a smartphone, let alone how to install and maintain networking equipment inside or outside their home. So whatever funding the infrastructure law provides for broadband will be wasted if some of that support isn’t directed to providing hands-on education and on-going support.

Public education about why the infrastructure bill is spending money on broadband will also be critical to getting maximum value from any new investment. That effort should include, at a minimum, the White House and related Departments including those dealing with commerce, housing, health, energy and education.

The FCC should be tasked with coordinating the public outreach, and for working with start-ups and established companies developing the most exciting and relevant applications and their respective trade groups in public-private partnerships.

Question 2. Are there specific tools such as commonly-mandated forms or commonly-mandated resolution timeframes (e.g., “shot clocks”) that can be standardized across all Federal agencies to improve the permitting process? What are the benefits and challenges to such efficiencies?

Answer. The more any proposed legislation includes and mandates already-understood permitting “best practices” across federal—and, where possible, tribal, state and local governments—the more effective and efficient future deployments will be.

Many of these practices have been developed by innovative Federal agencies and local authorities experimenting with ways to accelerate the deployment of fast-changing broadband technologies in specific geographies and communities, taking into account geological challenges and local preferences.

They include the “dig once” and “climb once” policies advocated by the White House and Congress, “shot clocks” that result in applications being deemed granted if a decision is not reached in a reasonable timeframe, and master contractor agreements for new infrastructure deployments piloted by Google Fiber and other broadband providers for both wired and mobile deployments that streamline the process of permitting, rights of way, and gaining access to local facilities including buildings, roads, utility poles and other property.

Much has been learned over the last few decades of infrastructure deployment, and there is consensus on what constitutes the best and most effective permitting and other processes. I note several specific examples of these practices in my testimony, and there is a wealth of literature available from trade groups, academics, and think tanks that describe these practices in detail.

The difficulty, as your questions suggests, is not that we do not know how best to manage broadband deployment, but that we lack both uniform and enforceable standards that apply to all government actors, retaining local values and choice where appropriate.

The FCC, for example, has long-maintained shot clocks for mobile equipment construction application, but lacks the resources to adequately monitor compliance, let alone enforce its rules.

The Federal Government, likewise, has adopted a “dig once” policy for fiber conduit by way of several Executive Orders, but needs to extend that policy to public rights of way adjoining roads, and to state roads as well as federal.

Given the limits of executive authority to extend and enforce these best practices, particularly regarding state government, Congress should embrace permitting reform as part of any broadband infrastructure legislation it develops. That would be the most effective and efficient way to propagate these practices throughout the government.

¹² Monica Anderson and Andrew Perrin, *13 percent of Americans Don’t Use the Internet—Who are They?*, Pew Research Report, Sept. 7, 2016, available at <http://www.pewresearch.org/fact-tank/2016/09/07/some-americans-dont-use-the-internet-who-are-they/>

¹³ National Telecommunications and Information Administration, *Digitally Unconnected in the U.S. Who’s Not Online and Why?*, Sept. 28, 2016, available at www.ntia.doc.gov/blog/2016/digitally-unconnected-us-who-s-not-online-and-why.

Question 3. Can you explain the importance of taking a “technology-neutral approach” in any comprehensive infrastructure or tax legislative package considerations by this Congress and Federal regulating agencies?

Answer. There are many myths about broadband technologies that have infected policy decisions over the years, particularly at the FCC. These include, for example, a belief promoted by some legal academics with minimal technical or business knowledge that the only way to achieve universal and competitive broadband deployment is to lay fiber optic cable to every home in America, regardless of location or cost, and preferably as part of a federally owned and operated Internet infrastructure.

Similarly, the FCC has long emphasized directly and indirectly that only wired broadband is truly broadband, leaving other delivery technologies either de-emphasized or excluded from various programs.

These myths are both technologically inaccurate and counter-productive. Often, their proponents intentionally misread data about deployment in other countries to feed a demonstrably false narrative that without a nationalized, all-fiber network, the U.S. both is and will remain uncompetitive in the Internet economy.¹⁴

More to the point, these broadband myths explicitly and implicitly deter both public and private investment in alternative broadband technologies and investment models that would actually close the remaining U.S. digital divide quickly and efficiently. By insisting on a deployment model that is neither cost-effective nor politically viable, those who encourage these myths condemn some consumers, particularly rural and tribal residents, to being left out of the digital conversation longer than necessary, if not permanently.

As I noted in my testimony, there have long been multiple broadband technologies, including cable, cellular and in particular next-generation DSL, fixed mobile and satellite, that are better suited to deliver broadband to geographically remote and/or sparsely populated areas of the country. They provide increasingly fast speeds and high reliability, as well as more cost-effective capital and operating features.

Sadly, if these technologies were not treated as second-class options by self-styled consumer advocates and their colleagues inside the FCC, they would have been deployed even more aggressively in the last decades. That would not only have eliminated remaining broadband availability gaps sooner but would have led to accelerated development of these technologies. Their success would also have stimulated competition for more innovation in other potential broadband technologies, including broadband over power lines.

Fiber optics will continue to play an expanded role in Internet infrastructure, but for the foreseeable future, as the National Broadband Plan made clear, it is unlikely to become the sole last mile connection technology for a country as vast and sparsely populated as the U.S.

New cellular and cable technologies, including 5G and Docsis 3.1, will offer wider coverage and greatly accelerated speeds. But in many rural areas, as I noted in my testimony, fixed wireless technologies have proven themselves capable of providing high-speed last-mile connections to homes and businesses, with the promise of even better performance going forward.

Satellite-based solutions have likewise matured, as have hybrid fiber/copper technologies using existing telephone lines.¹⁵ Just this week, the FCC unanimously approved OneWeb’s application to launch a constellation of low-orbiting satellites that will, when operational, provide global Internet access.¹⁶ Many other satellite providers, including SpaceX, Ligado, Boeing, and Telesat, have pending applications.

The problem is that up until now Universal Service programs have either explicitly or implicitly favored wired technologies, for example by defining minimum broadband speeds above what is reasonably necessary or by setting latency stand-

¹⁴See Larry Downes, *How to Understand the EU-U.S. Digital Divide*, HARVARD BUSINESS REVIEW, Oct. 19, 2015, available at <https://hbr.org/2015/10/how-to-understand-the-eu-u-s-digital-divide>.

¹⁵Richard Bennett, *Wireless First: A Winning Strategy for Rural Broadband*, High-Tech Forum, April 11, 2017, available at <http://hightechforum.org/wireless-first-a-winning-strategy-for-rural-broadband/>.

¹⁶See Caleb Henry, *FCC Approves OneWeb for U.S. Market as it Considers other Constellations*, SPACE NEWS, June 23, 2017, available at <http://spacenews.com/fcc-approves-oneweb-for-us-market-as-it-considers-other-constellations/>. See also Larry Downes, *Ligado is Ready to Launch a New Mobile Network. Will the FCC Let Them?* FORBES, June 12, 2017, available at <https://www.forbes.com/sites/larrydownes/2017/06/12/ligado-is-ready-to-launch-a-new-mobile-network-will-the-fcc-let-them/#7d455e3b3831>.

ards in a way that intentionally if implicitly excludes satellite-based solutions.¹⁷ That means that neither network operators nor consumers can make use of Universal Service Funds that would otherwise be available to overcome cost issues.

Removing technologically-unsound prejudices from USF and elsewhere as part of any broadband infrastructure legislation will be crucial in achieving the goal of that legislation to close the digital divide, particularly for rural Americans. It will also stimulate even faster innovation in these and other broadband technologies—including those we can't even imagine today.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MAGGIE HASSAN TO
LARRY DOWNES

Question. It's clear there is major interest in improving access to broadband and the way we deploy broadband services. This national goal transcends party lines, and I'm pleased to be a part of this committee where I can work with colleagues on both sides of the aisle to make improvements. I would like to hear from you all, what is being done, and what *more* should be done to ensure rural Americans are not left behind as technology evolves and innovations emerge. Rural America is more complex and difficult to connect for many reasons, but every American should have the opportunity to reap the social and economic benefits of broadband connectivity. What are your thoughts?

Answer. Rural residents are making great strides in both access and adoption of affordable broadband Internet, but continue to trail urban and suburban consumers.

Just last week, the Pew Research Center released new data on the digital divide.¹ The good news is that the rural divide continues to shrink, both in absolute and relative terms:

Nearly two-thirds (63 percent) of rural Americans say they have a broadband Internet connection at home, up from about a third (35 percent) in 2007, according to a Pew Research Center survey conducted in fall 2016. Rural Americans are now 10 percentage points less likely than Americans overall to have home broadband; in 2007, there was a 16-point gap between rural Americans (35 percent) and all U.S. adults (51 percent) on this question.

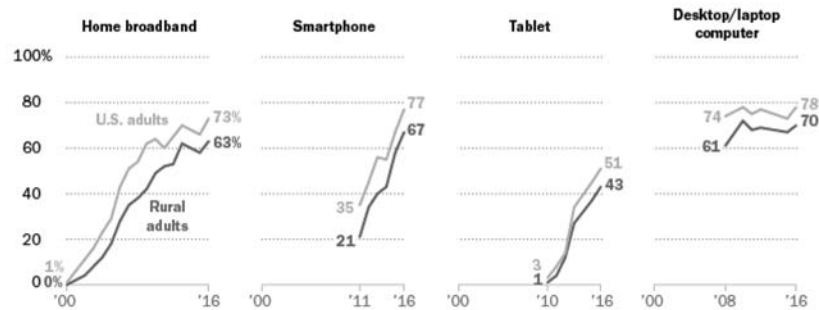
But, as Figure 1 makes clear, rural users continue to lag in adoption.

¹⁷See Doug Brake, *A Policymaker's Guide to Rural Broadband Infrastructure*, Information Technology and Innovation Foundation (April 2017), available at http://www2.itif.org/2017-rural-broadband-infrastructure.pdf?mc_cid=4fb4705a17&mc_eid=98756dc702.

¹Andrew Perrin, *Digital Divide Between Rural and Nonrural America Persists*, Pew Research Center, May 19, 2017, available at http://www.pewresearch.org/fact-tank/2017/05/19/digital-gap-between-rural-and-nonrural-america-persists/?utm_campaign=Newsletters&utm_source=sen_dgrid&utm_medium=e-mail.

Despite growth, rural Americans have consistently lower levels of technology adoption

% of U.S. adults who say they have ...



Source: Survey conducted Sept. 29-Nov. 6, 2016. Trend data from other Pew Research Center surveys.

PEW RESEARCH CENTER

Figure 1

There are, of course, many explanations for the remaining gaps. As the Pew research notes, some rural parts of the country still lack access to basic broadband infrastructure. Where broadband is available, it may be less reliable or offered at slower speeds. And rural users may believe, rightly or wrongly, that Internet products and services are not relevant to their lives.

Indeed, according to multiple surveys, the largest impediment today to universal broadband adoption is neither availability nor cost—it's a perception by non-adopters that there's nothing online of interest to them. According to Pew, "[a] third of non-internet users (34 percent) did not go online because they had no interest in doing so or did not think the Internet was relevant to their lives." Researchers reported that "Another 32 percent of non-internet users said the Internet was too difficult to use, including 8 percent of this group who said they were 'too old to learn.'"²

While access and price undoubtedly continues to play a significant role in non-adoption, in other words, many who remain offline wouldn't use the Internet even if it were free. This conclusion was also reached by a recent NTIA survey, which found that over half of those who don't have Internet service at home—largely rural and older Americans, and those with less education—say they just don't want or need it.³

As the improving relative and absolute adoption rates suggest, however, a combination of private and public-private initiatives aimed at both access and adoption gaps have and continue to make excellent progress in overcoming these real and perceived obstacles.

Basic technology costs continue to decline, and new infrastructure technologies are invented and rapidly improve. Together, these translate to high-speed access becoming increasingly cost-effective even in the most geographically remote parts of the U.S.

Cable providers continue to expand their networks, and new protocols increase the speed and reliability of those networks. Hybrid fiber/copper options that utilize existing telephone infrastructure have brought high-speed broadband to many areas that are otherwise too expensive to serve.

New wireless technologies, including fixed wireless systems utilizing existing 4G LTE networks, are both more cost-effective and competitive with wired solutions.

² Monica Anderson and Andrew Perrin, *13 percent of Americans Don't Use the Internet—Who are They?*, Pew Research Report, Sept. 7, 2016, available at <http://www.pewresearch.org/fact-tank/2016/09/07/some-americans-dont-use-the-internet-who-are-they/>

³ National Telecommunications and Information Administration, *Digitally Unconnected in the U.S. Who's Not Online and Why?*, Sept. 28, 2016, available at www.ntia.doc.gov/blog/2016/digitally-unconnected-us-who-s-not-online-and-why.

And, as we heard at the hearing, low-orbit satellite broadband services have the potential to deliver competitive service without introducing latency that reduces the usefulness of some applications, notably high-definition video.

For those areas of the country where these alternatives remain difficult to cost-justify, programs administered by the FCC, including the Connect America Fund and Mobility Fund, have accelerated the push to provide needed capital for infrastructure investment. The agency has committed even more revenue from the Universal Service Fund to these programs, and there remains the potential for Congress, as part of a possible infrastructure bill, to increase those funds even more.

Just last month, FCC Chairman Pai announced the formation of a Rural Broadband Auctions Task Force,⁴ tasked with implementing auction-based allocation of another \$6.5 billion in rural infrastructure funding.

Earlier in the year, Chairman Pai also announced the creation of a Broadband Deployment Advisory Committee.⁵ The Committee, composed of leaders from both public and private sector organizations at the federal, state and local levels, has as its mission:

[T]o make recommendations for the Commission on how to accelerate the deployment of high-speed Internet access, or “broadband,” by reducing and/or removing regulatory barriers to infrastructure investment. This Committee is intended to provide an effective means for stakeholders with interests in this area to exchange ideas and develop recommendations for the Commission, which will in turn enhance the Commission’s ability to carry out its statutory responsibility to encourage broadband deployment to all Americans.

Supplementing these efforts, the Commission has initiated several Notices of Proposed Rulemaking to implement specific changes aimed at improving the speed and efficiency of both public and private broadband deployment initiatives.

Finally, for rural Americans for whom cost is a barrier to broadband adoption, both private and public efforts to reduce or subsidize the price of connection continue to bring more Americans online. Most major broadband providers, following the early efforts of Comcast, AT&T and others, have programs that provide reduced price service (about \$10 a month) for lower income Americans and their communities. Likewise, the FCC continues to transform Universal Service programs originally designed to subsidize wired voice service into programs aimed at both wired and mobile broadband.

Recommendations

As I noted in my written testimony, however, there are still ways in which these positive developments can be further improved. Specifically, I identified eight reforms that Congress should consider including in future infrastructure spending or otherwise. (A detailed explanation for each can be found in my written testimony.)

1. *Limit and carefully control direct investments.* Any direct infrastructure spending Congress approves should be targeted exclusively to the few remaining census tracts, mostly rural and tribal, where there is currently no competitive broadband service. Congress should consider setting aside a modest portion of its proposed infrastructure fund, say \$20 billion, for a one-time rural broadband acceleration program.
2. *Severely limit ongoing support.* To date, Federal efforts to overcome the financial hurdles to deploying rural broadband infrastructure have suffered from a structural flaw. The FCC provides payments in the form of small ongoing annual subsidies, even in areas when all that was needed to overcome high infrastructure costs was an initial capital investment.

Future investments should avoid this error by offering instead carefully-calculated one-time subsidies. While some truly high-cost areas will continue to need both start-up capital and operating support, the emphasis for any new rural broadband infrastructure spending should be on those locations for which capital alone can overcome the need for further government subsidy.⁶

3. *Extend “Dig Once.”* Lack of coordination between broadband and other infrastructure projects wastes time and resources, particularly when roads are being built or maintained. It is essential that we fully embrace a “Dig Once” rule, requiring installation of conduits for broadband equipment whenever

⁴ See https://apps.fcc.gov/edocs_public/attachmatch/DOC-344201A1.pdf.

⁵ See <https://www.fcc.gov/broadband-deployment-advisory-committee>.

⁶ See Blair Levin and Carol Matthey *In Infrastructure Plan, a Big Opening for Rural Broadband*, Brookings Institution, Feb. 13, 2017, available at, <https://www.brookings.edu/blog/the-avenue/2017/02/13/in-infrastructure-plan-a-big-opening-for-rural-broadband/>.

roads are being dug up for any reason. According to the Government Accountability Office, “Dig Once” can reduce the cost of deploying fiber under highways in urban areas up to 33 percent and up to 16 percent in rural areas.⁷

4. *Address other unproductive barriers to mobile deployments.* Congress should establish Federal guidelines to eliminate unnecessary bickering over pole attachments, especially for poles that are municipally-owned or owned by regulated utilities. To avoid rent-seeking behavior that grinds the process to a halt, we need cost-based attachment fees, “climb-once” policies, and basic rules about notice and contractor qualifications. Network operators should not be penalized in either time or money for replacing or upgrading small cell equipment—applications that are often treated as full-scale installations of new towers.
5. *Re-engineer government processes that hinder private investment.* Beyond pole and building access issues, both wired and mobile deployment is being held back unnecessarily by unproductive costs associated with dealing with slow and overly bureaucratic local governments. The problem is not so much local regulations as it is local processes—or often, the lack thereof. Best practices distilled from a long history of good and bad examples should be established at the Federal level and included in the infrastructure bill as conditions for local jurisdictions to receive Federal assistance.
6. *Make investments technology-neutral.* Until now, Universal Service programs have either explicitly or implicitly favored wired technologies, for example by defining minimum broadband speeds above what is reasonably necessary or by setting latency standards in a way that intentionally excludes satellite-based solutions.⁸ No matter how the infrastructure bill provides for broadband in the remaining unserved locations, it should do so on a technology-neutral basis to encourage continued development of new options.
7. *Address nonfinancial causes of the digital divide.* Many unconnected Americans don’t know how to use a computer or even a smartphone, let alone how to install and maintain networking equipment inside or outside their home. Whatever funding the infrastructure law provides for broadband will be wasted if some of that support isn’t directed to providing hands-on education and ongoing support. Community groups and senior centers are natural conduits for these essential services, along with private programs that are today underfunded.
8. *Use the bully pulpit to encourage digital want-nots.* Public education about why the infrastructure bill is spending money on broadband will be critical to getting maximum value from any new investment. That effort should include, at a minimum, the White House and related Departments including those dealing with commerce, housing, health, energy and education.

Following these basic recommendations will maximize the value of any taxpayer money spent on broadband infrastructure. Even more, these simple steps will help multiply government spending with continued private investment, accelerating efforts to close the digital divide and bring the least-connected parts of the country into our growing digital conversation.

In Silicon Valley, that’s what we call a win-win-win.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JERRY MORAN TO
BRIAN M. HENDRICKS

Question. I am excited to see Kansas serving as a leader to other states by successfully accelerating wireless deployment and investment by streamlining their processes through its state legislature. I understand that other states have not been able to reach similar state-level legislative solutions.

a. Do you think the patchwork of deployment laws across the states will impact uniform investment and deployment 4G and 5G infrastructure?

Answer. Senator Moran, yes, Nokia believes that a patchwork of laws and local zoning practices creates a significant problem. As I noted in my testimony, in order to evolve our wireless infrastructure further under the hypothetical Fifth Generation (5G) umbrella that will require networks to have near zero latency (delay in

⁷See Letter from Government Accountability Office, June 27, 2013, available at <http://www.gao.gov/assets/600/591928.pdf>.

⁸See Doug Brake, *A Policymaker’s Guide to Rural Broadband Infrastructure*, Information Technology and Innovation Foundation (April 2017), available at http://www2.itif.org/2017-rural-broadband-infrastructure.pdf?mc_cid=4fb4705a17&mc_eid=98756dc702.

transmission of packets) and extremely high peak data rates, we will need to deploy hundreds of thousands of small cells, distributed antenna systems (DAS), and other micro-infrastructure. Doing this will allow current networks to support use cases with zero fault tolerance like autonomous driving vehicles. Making substantial upgrades to large macro tower sites as the primary, or only method, to increase capacity and coverage in 5G rather than utilizing smaller cells to bolster and evolve 4G networks does not make technical or economic sense.

In order to achieve ubiquitous deployment of 5G in the U.S., we need to ensure that there are predictable, non-burdensome frameworks available to process the many thousands of small infrastructure applications we anticipate. When a service provider and a vendor partner like Nokia look at areas for deployment planning purposes, you want the considerations to be: (1) what infrastructure is already deployed, (2) how is the network performing and what is the user experience like, and (3) what new equipment makes the most sense for this area to increase coverage, capacity and performance to support the emerging Internet of Things (IoT) vision of a connected society. You do not want a variable in that equation to be the regulatory environment.

We have seen deployments quickly become infeasible due to things like: (1) requirements to submit numerous applications for a single, multi-site deployment, (2) requirements that three or more agencies must sign off on an application in serial rather than using concurrent review, and (3) initial connection fees and recurring monthly “rents” that exponentially increase the cost of the project. Modest projects, such as a the hypothetical 200 small cell deployment I mentioned in the hearing, quickly amass costs in the millions of dollars just to obtain regulatory approval and access. That is before we have even purchased the equipment, established connectivity and power, or served a single customer.

What the foregoing will produce, if unchecked, is a very uneven deployment of these new network components. For example, prioritizing one urban area over another, or one suburban or mid-sized city over another based primarily on a regulatory cost vs. economic opportunity analysis. We have already begun to see this happen. Many cities across the country have expressed interest in demonstration deployments for special events, or to do early deployments of connected infrastructure or Smart Cities technology. Unsurprisingly, the cities chosen for early deployment share in common a few characteristics, including: well established processes, dedicated personnel to review and facilitate approval and siting, and fees that are tied closely to the actual costs incurred by the city in furnishing access.

Nokia believes that a more harmonized framework across the country would greatly aid in planning and deployment of the next generation networks. Some of these concepts are discussed in my response to the next question. Importantly, if we do not see greater consistency in the processes, fees and other circumstances related to siting of 5G infrastructure, roll out of the technology will be very uneven across the U.S. And, that has important implications because 5G is an essential development to ensure that all of the contemplated uses cases, from connected healthcare and its improved access to diagnostic and therapeutic medicine to intelligent transportation are available to all Americans. Closing the digital divide between communities with robust broadband access and those without it has been a major policy priority. We do not want lack of common sense, reasonable siting policies in many jurisdictions to be a reason the divide grows further.

b. What further actions can the Federal Communication Commission (FCC) take to incentivize the deployment of 4G and 5G infrastructure?

Answer. The FCC has played an important role over the last few decades in promoting the deployment of communications networks that meet the needs of consumers by providing guiderails where necessary to achieve deployment goals. The FCC can do so again today by modernizing its approach to wireless siting to reflect the unique challenges of further building out today’s 4G LTE networks and tomorrow’s 5G networks.

As I previously noted, dense networks of smaller wireless facilities are key to creating the capacity needed to support next-generation wireless networks. Small cells are usually no more than a few feet in dimension and are typically placed on existing structures like rooftops, water towers, and the sides of buildings, or our poles along local streets and rights of way. Although some states and localities are beginning to understand the importance of small cell technologies and are streamlining local policies to facilitate their deployment, many others are imposing on small cells the same types of regulations, laws, and requirements that govern macrocell (large, frequently tower-based) deployments. These barriers can take several forms, including those I mentioned in my response to the preceding question and through direct or de facto prohibitions on new wireless infrastructure.

The FCC can address these barriers without undermining localities' important role in permitting new facilities. Specifically, the FCC can ensure that localities issue permits for wireless facilities that allow them to fully recover their costs to process the permits, but that nevertheless are issued within reasonable timelines and without unreasonable requirements (so-called shot clocks, prohibitions against moratoria and policies that severely restrict deployment based on arbitrary criteria such as not putting a small cell on a pole more than 30 feet in height). Doing so will enable the rapid buildout of next-generation networks and will foster connected, smart communities across the country. There are multiple ways to achieve this. The FCC could utilize its open proceeding to establish a framework for reasonable fees and "shot clocks" that states and localities must follow. The Commission could then utilize its Broadband Deployment Advisory Committee (BDAC) to create a set of model processes, perhaps a template, that states and localities could adopt as an operating framework. The BDAC should include more representation from state and local governments than it does at this time to further that collaborative process. Following its rule making and BDAC process, the Commission would be in a strong position to review ongoing siting practices and provide relief where unreasonable or unworkable practices remain. Congress should also consider augmenting the tools that the Commission has to effectuate this type of outcome by clarifying Sections 253 and 332 of the Communications Act.

c. What role do you see a potential comprehensive infrastructure package playing in modernizing Federal deployment laws and rules?

Answer. Senator Moran, we believe that a comprehensive infrastructure package is an excellent policy opportunity for Congress. With respect to broadband, we have noted that a fiscal component should be included, and that there are a variety of ways in which Congress can incentivize and enable early deployments of 5G and IoT technology on a small scale. We also believe that there are opportunities to further address the complexities of rural deployment.

With respect to Federal deployment laws and rules, Nokia is cognizant of the challenges in attempting to reform siting policies and rules related to Federal land and buildings, particularly because there are multiple committees in both the House and Senate with a jurisdictional claim to the effected agencies. That makes a single, stand alone bill addressing siting much more difficult to effectuate. The nature of a comprehensive infrastructure package, which of necessity will involve inputs and collaboration across multiple committees, makes it more sensible to address the issue of broadband infrastructure siting comprehensively.

Such a bill will likely include policy and fiscal focus on highways in which so-called "dig once" language can greatly increase the availability and cost effectiveness of fiber for future broadband needs. Similarly, an infrastructure bill will likely include a section dealing with broadband and the programs administered by both the FCC and the Department of Commerce (NTIA) making it reasonable to further clarify FCC authority over infrastructure siting practices at the state and local level. In addition, broadband is likely not the only technology or activity that can benefit from a review and alteration of policies and practices at multiple Federal agencies including the Department of the Interior that play a role in determining access to Federal lands and buildings. Congress is in a strong position to utilize incentives to these agencies to adopt reforms, or to prescribe what processes should look like for review of applications. And, further, to provide a deemed granted framework or other approval mechanism that grants applications for access if the agencies fail to follow the prescribed practices.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MAGGIE HASSAN TO
BRIAN M. HENDRICKS

Question 1. It's clear there is major interest in improving access to broadband and the way we deploy broadband services. This national goal transcends party lines, and I'm pleased to be a part of this committee where I can work with colleagues on both sides of the aisle to make improvements. I would like to hear from you all, what is being done, and what *more* should be done to ensure rural Americans are not left behind as technology evolves and innovations emerge. Rural America is more complex and difficult to connect for many reasons, but every American should have the opportunity to reap the social and economic benefits of broadband connectivity. What are your thoughts?

Answer. Thank you, Senator Hassan, for your leadership and the opportunity to provide Nokia's views. Rural deployment of broadband has been a decades long challenge. There are several reasons for this, including: (1) lower population densities that in turn provide fewer subscribers to facilitate a workable business case, (2)

even where broadband has been available, we have done a poor job as an industry of creating interest in adoption by rapidly advancing the use cases to make adoption a high value proposition for all consumers, and (3) the high cost of deploying fiber to every home, and technical limits in early wireless technology. High adoption rates are even more critical in areas where you may have fewer enterprise customers (businesses), fewer anchor institutions, and smaller pools of consumers.

There are some promising signs that we may be able to overcome some of these previous challenges. One the “wired” side, the cost of fiber has declined, making new deployments much less costly. In addition, provisions such as “dig once” that will require future highway projects to include conduit for future fiber deployments will cause further cost efficiencies by avoiding much of the cost of trenching for new cable to be laid. Nokia has also made significant advances in technology that allow for the use of already deployed copper infrastructure to provide ever higher broadband speeds. Speeds up to 1 Gbps in the transport area of networks are now feasible in certain circumstances, which in turn increases data speeds available to consumers.

With respect to wireless, prior generations of wireless broadband have been able to greatly expand the availability of broadband to consumers, but not always at data rates that made wireless a competitive alternative to other services. That changed significantly with the deployment of the 4th generation (4G) of wireless. Peak data rates have risen considerably in the last five to seven years, and further evolutions are anticipated between now and 2020 that will bring mobile broadband speeds to a much higher level.

Recognizing that in rural areas there are still challenges, including lower data rates for individuals that live miles away from the nearest cell tower, Nokia has worked on solutions that can increase the performance of current wireless service. One product, called FastMile, allows a consumer to mount a very small multi-directional antenna on their premises through a self-install process. This increases the normal coverage area available to consumers by 12x and can increase available throughput and data rates by 2.5x. The design of this technology is attractive to wireless service providers because it can be overlaid on their current infrastructure deployments and utilizes different frequency bands than the underlying network, many of which are underutilized in rural areas. The net effect of this is to dramatically change the business case for rural deployment of high quality mobile broadband.

To build on these developments, Congress could consider:

- Further work on spectrum, particularly in identifying low band spectrum (below 6 GHz) because the propagation characteristics are well suited for all types of deployments, and particularly good for rural deployments. Nokia strongly recommends that Congress prioritize the range of 3.1–3.55 GHz and 3.7–4.2 GHz, both in the MOBILE NOW Act;
- In any infrastructure bill that includes broadband, direct additional resources toward foundational research into increasing performance of currently deployed copper and fiber infrastructure, and solutions that can increase the efficiency of spectrum use or utilization of lightly used bands available in rural areas.

Question 2. Mr. Hendricks, as we prepare for the future of wireless networks and pave the way for 5G networks specifically, I think it would be useful to shed light on what 5G will mean for Granite Staters and people across the country. What will our devices be able to do with 5G that they can't do today? What will 5G mean in practical terms for our constituents? What are the biggest impediments to deploying 5G throughout the country and particularly in rural areas like those in my state of New Hampshire?

Answer. The short answer to what can consumers expect from 5G is this: a truly portable and programmable world. They will be able to have access to the information and services they value, wherever they are, with an expectation of reliability that is much higher than even current LTE networks provide. They will be able to conduct commerce, access high bandwidth services including health care, and monitor and control appliances. They will have access to lower cost transportation due to the cost reduction benefits produced by autonomous vehicles. Some of the more exciting aspects of the programmable world Nokia sees include the potential for remotely delivering not just diagnostic, but therapeutic health care services, greatly improving the quality of the rural health care delivery system.

As I noted in my written testimony, the United States is fortunate to have excellent wireless networks. But, it is important to note that 3G networks were engineered primarily for voice and to support basic data including text. The 4G (LTE) networks deployed in the last seven years made an exponential leap in capability, but they were still designed primarily for voice and higher speed data to support

applications like social networking and streaming video. The capacity in these 4G networks has been tested at times, in part because of wider adoption of smart phones and the introduction of other handhelds such as tablets and by the emergence of streaming services like Netflix. Wireless carriers have stayed ahead of these demands with increases in spectrum utilization efficiency and network management.

As we look to the future, we need to be cognizant of network performance issues including peak data rates and latency (delay in transmission). Current networks have made significant progress in peak data rates, but still see levels well below what will be necessary to support applications with a zero-fault tolerance and which require massive bandwidth such as autonomous driving vehicles and some aspects of health care.

There is a distinction between “connected” transportation, which relays data to and from a vehicle but the driver remains the controlling interface with the road, and truly autonomous vehicles whose critical operating systems including braking cannot depend on a network with insufficient capacity and performance. LTE networks of today are well suited for connected transportation (information relay to the vehicle). But with latency of 35–60 milliseconds, they are less well suited in their current deployment configuration to ensure safe, autonomous vehicles on a mass scale. Similarly, connected health care, which can include remote diagnostic services and even some imaging is quite different than conceptual ideas like remote surgery that will require latency to be near zero.

What the foregoing makes clear is that there is a distinction between applications where basic data is being transmitted from sensors (connected health, transportation, some aspects of smart metering) and services which will require much more bandwidth and much lower latency. It is not inconceivable that we will see a true industrial Internet, with remote operation of large machinery, a tactile Internet that allows remote surgery, and the transmission of real time 4K quality video as part of virtual or augmented reality.

The challenge, as I noted in my testimony is that these use cases are arriving at the same time billions of new devices will be connecting to current networks, ranging from sensors on appliances and information interfaces in transportation to health care devices and services. From a challenge standpoint, we must be able to deploy hundreds of thousands of new small cell and related technologies to “densify” the LTE networks already deployed and to evolve them further. This involves several challenges: (1) creating the technology and making it small, cost effective, and higher performing, (2) gaining access to the necessary rights of way and other structures at a local level to make these deployments, and to avoid egregious charges for access that compromise the financial viability of the projects, and (3) as I noted in the foregoing question, continuing to find ways to get more performance from the infrastructure that has been deployed already through additional spectrum allocations for mobile broadband applications.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. CATHERINE CORTEZ MASTO
TO BRIAN M. HENDRICKS

Question 1. In your testimony, you spoke about Nokia’s personal experience with the frustrating siting process. Can you elaborate more on any specific challenges Nokia has faced in connection with any permitting on Federal lands or with Federal facilities?

Answer. Thank you Senator for the questions and for your engagement on these issues. As I noted at the hearing, Nevada has been very forward leaning in its technology policy on a bipartisan basis. We frequently have conversations with local officials including infrastructure planners about their needs and interests, and they regularly inquire about changes they can make to policies to enable rapid deployment of new equipment. Industry has spent considerable time focusing on the issues with state and local government processes, which remain problematic, so I believe it is important to note examples of governments that are working hard to enable 5G and the connected society vision when we do encounter them. We have spent less time on the Federal issues. So, thank you for providing an opportunity to offer more information.

Our experience siting on Federal lands varies based on several factors, including: (1) the responsible agency, (2) the policies and practices (if indeed there are any), and (3) personnel issues. On the personnel side, as with the state and local environment, we often find at both the agency regional office and the national level there are limited personnel resources dedicated to application review. Policies for handling applications have not been effectively communicated to all responsible staff and

training in the policies and the procedures for processing applications has not been sufficient. Regions where the amount of Federal land tend have more resources, so the resourcing issues are magnified in states where there is relatively little Federal land being managed. Applications for siting on Federal land can take many months, or even years and there is no effective guidance or rule governing how quickly the applications must be reviewed and acted upon. Some of the process length is due to the list of regulatory requirements including impact studies, but much of the length is due to personnel limitations and training issues.

Question 2. You also mentioned that the lack of employee resources exacerbates a number of other impediments. Can you elaborate on the impact that a lack of sufficient staff within Federal agencies, like the Department of Interior, or others, have on this process? How do you think the Federal hiring freeze has further impeded the efficiency of processing applications?

Answer. Roughly 28 percent of the land in the U.S. is owned by the Federal Government. It is therefore critical for the wireless industry to have access and the ability to construct facilities on Federal lands, properties, and buildings, particularly in rural and remote areas that more often consist of Federal lands. The industry works with numerous Federal agencies that manage those lands so that facilities can be constructed. But, the processes vary greatly across agencies and can often take years to complete. The lack of uniform processes, including timelines for required action and procedures for reviewing and responding to applications is not a personnel issue, it is an issue of not prioritizing siting as a function of the agency. This is something that Congress has, and can continue to address.

Ensuring that agencies are appropriately staffed, imposing additional Congressional oversight on agencies administering Federal lands, and encouraging adoption of standardized deadlines and processes for reviewing wireless siting applications will promote new infrastructure construction for the benefit of Federal employees and, more broadly, American consumers.

Nokia cannot say definitively whether the hiring freeze has (or will) exacerbate the problems we have experienced. However, it is safe to say that the freeze limits options to overcome the staffing limitations. A few practical suggestions that can improve siting on Federal land include:

- At each relevant agency that is involved in the review and approval of siting on Federal lands, direct that the head of the agency appoint a career employee, and/or to establish an office that is responsible for:
 - (1) maintaining an updated policy document regarding infrastructure siting on Federal land under their jurisdiction;
 - (2) providing points of contact within the agency that can answer questions (ombudsman like approach) and ensuring that all regional offices have at least one employee responsible for reviewing and responding to applications; and
 - (3) developing and clearly communicating training on the agency procedures to regional office staff.
- Establishing standardized application review and approval timelines, and providing a mechanism for deeming applications approved if they are not acted upon within these time periods; and
- Consider streamlining or waiving the application of any remaining Federal regulations that impose impact analysis requirements on equipment below a certain size.

Question 3. In our discussion during the hearing, we discussed your highlighting of Smart Cities. I just wanted to follow-up and get your response about whether: (a) Nokia was a partner with any communities who applied for the USDOT 2015 Smart City Challenge? And (b) Would Nokia be looking to engage with public and private sector applications for any similar efforts in the future?

Answer. During this particular challenge Nokia was completing our acquisition of infrastructure provider Alcatel-Lucent and divesting other non-core businesses to re-tool our market strategy. We did not have some of the core competencies that were necessary to make a compelling partner. Following completion of the acquisition, Nokia announced an aggressive move into certain vertical markets including Smart Cities where we believe our products are a compelling fit. We anticipate being active as partners with cities on future applications and have been working on projects in non-U.S. markets such as connected sewer, connected bus shelter and port security. I have included here a link to our smart city site that includes a high-level summary of our vision, potential capabilities, and links to white papers and other items of interest. <https://networks.nokia.com/smart-city>

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JERRY MORAN TO
HON. JEFF WENINGER

Question 1. Kansas was one of the first states in the Nation to pass legislation to eliminate barriers to wireless broadband deployment. In 2016, the Kansas legislature passed and the Governor signed this bill into law to help expedite the deployment of small cell technology in the state. Small cell technology will be the backbone of the next generation wireless technology and networks, known as 5G. Since this bill was signed into law last year, Arizona, Ohio, Colorado, and Virginia have all signed into law similar bills. Indiana, Iowa, and Florida have passed similar bills that are waiting action by their Governors.

a. Given the wide range of deployment processes and associated fees across the country, do you anticipate wireless providers utilizing certain states' streamlined state-level deployment laws like those found in Arizona and my home state of Kansas?

Answer. I definitely believe that the cell companies will use this as a large part in their decision making process. The fact that Kansas and Arizona have a friendly predictable environment now should be a very positive factor. I am sure population and density will play a factor as well.

b. How do you see states like Arizona and Kansas serving as models of favorable pathways for deployment to other states? And the Federal level?

Answer. I believe our states have set the bar for the others to follow. After I had the privilege of testifying I truly believe a national model is the way to go. This is critical infrastructure in this era. We have to pull together and allow ourselves to succeed. I believe there are some states that will need some flexibility for weather and different local issues, but I believe you can come up with a way to make it work.

c. Your written testimony mentions the "productive discussions" between industry and local leaders that were coordinated leading up the introduction and enactment of Arizona's state law promoting investment in small cell deployment. Could you please elaborate on these conversations and their ability to reach a productive consensus?

Answer. The large group of stakeholders had fifteen to twenty meetings. At first it was tense and it was tough to find common ground. We slowly found out what was the most important issues that the sides had. The cell companies main issues were price and having the same process for every locale. They needed a price that was reasonable and a process that was efficient.

The municipalities main concerns were for public safety, design standards, and concealment requirements. Cities and counties have spent years making these areas beautiful and it's understandable that they want to keep it that way.

I also believe that the fact that I am a former city councilman of eight years helped. I understand the issue of local control and not wanting to give that up. But I also understand and conveyed to them that this isn't like any other issue. This is critical infrastructure that their constituents want and need.

Question 2. In your experience, are there examples where state-level reviews (like environmental reviews) of a permitting application can be used by the Federal Government to avoid needless duplication?

Answer. I believe that it would be much more efficient to allow the states to act as the approval mechanism for a Federal program. The main goal is to make this efficient as possible and to your point duplicating reviews by the Federal Government will certainly delay deployment.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. DAN SULLIVAN TO
HON. JEFF WENINGER

Question. The construction season in Alaska is shorter than most. This does not allow for delays caused by roadblocks in the federal, state, or local permitting process. For example, one of our carriers in Alaska experienced delays and increased costs in getting permission to install towers in building out their network. This situation involved only a few towers, with a small footprint, in a large national wildlife refuge.

a. Representative Weninger, do we need to consider improved tools like reasonable shot clocks and "deemed granted" remedies in any infrastructure package?

Answer. I believe there needs to be shot clocks and deemed granted policies. Without them there is no mechanism to make this happen in an efficient manner. You can still approve these in batches and pull out the ones that the planning depart-

ment believes has issues. These are large investments in communities that the citizens and the government want. I am at a loss as to why communities would want to delay such an investment.

b. What are the benefits and challenges to enforcing such mechanisms?

Answer. The benefit is faster deployment, predictability, jobs, investment and our country being a leader into the 5G world.

The challenge is does the policy have any teeth if it's not followed? Are some communities doing everything they can to put up roadblocks? I would think and hope that situation would self correct. It is possible that such behavior might put a community to the back of the deployment line.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MAGGIE HASSAN TO
HON. JEFF WENINGER

Question. It's clear there is major interest in improving access to broadband and the way we deploy broadband services. This national goal transcends party lines, and I'm pleased to be a part of this committee where I can work with colleagues on both sides of the aisle to make improvements. I would like to hear from you all, what is being done, and what *more* should be done to ensure rural Americans are not left behind as technology evolves and innovations emerge. Rural America is more complex and difficult to connect for many reasons, but every American should have the opportunity to reap the social and economic benefits of broadband connectivity. What are your thoughts?

Answer. I believe a combination of things can be done to speed up deployment of cellular technology in rural America.

1. I believe targeted tax credits to the companies deploying this technology is appropriate in these specific rural areas. This is critical infrastructure in today's society.
2. I like the idea that your committee has put forward involving the use of government facilities and land for deployment in rural areas. Between government owned land and government facilities there are enormous opportunities to deploy this technology throughout rural America.
3. The Federal Government should allow the deployment of this technology at Federal Government facilities and land in rural America for no charge. The investment in jobs as well as rural economic development dollars that would flow would more than make up for an arbitrary fee that discourages investment.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MAGGIE HASSAN TO
HON. GARY RESNICK

Question. It's clear there is major interest in improving access to broadband and the way we deploy broadband services. This national goal transcends party lines, and I'm pleased to be a part of this committee where I can work with colleagues on both sides of the aisle to make improvements. I would like to hear from you all, what is being done, and what *more* should be done to ensure rural Americans are not left behind as technology evolves and innovations emerge. Rural America is more complex and difficult to connect for many reasons, but every American should have the opportunity to reap the social and economic benefits of broadband connectivity. What are your thoughts?

Answer. Senator Hassan, thank you for this question. Many communities around the country, particularly in rural areas, do not have access to broadband services, and even those that do have broadband, certainly do not have the level of broadband services or competition to improve service and rates that many urban areas enjoy. During my eight years on the FCC's Intergovernmental Advisory Committee and my decades of working on these issues with the National League of Cities, I have heard from many local officials across the country that have clamored for broadband service, often offering financial incentives and other assistance to broadband providers to deploy facilities to serve their constituents. Unfortunately, there have been few if any takers. Even my own City, which is within dense, urban southeast Florida, until recently, was served by only one wireline broadband provider until we convinced a second that with greater density occurring, it made sense to build out our City.

The reason broadband providers do not reach rural and other communities is simple. As industry itself will plainly state, there is simply no current business plan that would support expanding or offering such services in these communities. There

is not sufficient return on investment for the industry to commit the capital to build facilities in these areas, particularly compared to the return the industry can realize by deploying more infrastructure in dense and wealthy areas.

Obviously, local government siting regulations do not impair the ability to offer broadband services in rural and other less attractive areas. Quite the contrary, often such local governments will offer incentives and other assistance to providers to deploy their service in their communities. However, even such incentives do not entice providers to do what their bottom line concerns and shareholders will not support. Many local governments required complete buildouts to ensure that broadband infrastructure was deployed throughout cities and counties, even where the return on investment was lower. Such local buildout requirements have been opposed by industry and prohibited in many states.

In many cases, the local governments realized that the only way to bring quality, affordable broadband to their constituents was to provide it themselves. Unfortunately, the industry has opposed government broadband, often lobbying state legislatures to place prohibitions and other roadblocks on municipal broadband. Recently, the U.S. Court of Appeals for the Sixth Circuit upheld such state prohibitions in Tennessee and North Carolina.

There are several actions the Federal Government could take to encourage the deployment of broadband infrastructure in such areas.

- (1) The process for access to Federal lands for the deployment of broadband infrastructure should be made more predictable and easier.
- (2) Congress must ensure that FirstNet services meet their stated Federal goal of serving both urban and *rural* communities. FirstNet has the very real potential of bringing advanced services to rural communities.
- (3) Federal and state policies should support, rather than restrict, local governments' broadband initiatives. Many cities, for example, seek to install conduit as part of transportation roadway projects, to make it easier for broadband providers to deploy fiber. However, Federal funds for such transportation projects may not allow installation of conduit, even at the local governments' expense. Federal funds for roads, bridges, water and other infrastructure should be available for broadband infrastructure as well. Federal law should also allow local governments to provide broadband services if such governments decide to do so.
- (4) Finally, Congress should consider subsidies or tax incentives that may spur private investment, which, coupled with potential public funding, would actually bring these vital services to rural America. Further, many states are now granting tremendous taxpayer subsidized incentives to the industry in the form of free or basically free access to government property in the rights of way, to deploy infrastructure. Governments should be able to negotiate for the benefit of their constituents in exchange for such valuable subsidies. In this day and age, it is absolutely outrageous that there are large segments of Americans that do not have access to affordable, quality broadband service. If left to market forces, this will continue. However, compared to other issues confronting our nation, this does have readily available solutions. Thank you again for the opportunity to respond.

